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ANNALS

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NEW YORK ACADEMY OF SCIENCES,

VOLUME IV.

I.—*A Review of the Chætodontidæ of North America.*

BY CARL H. EIGENMANN AND JENNIE E. HORNING.

Read January 31st, 1887.

In the present paper is given the synonymy of the genera and species of North American *Chætodontidæ*, together with analytical keys by which the species and genera may be recognized.

The specimens studied belong chiefly to the Museum of the Indiana University, duplicates of all being also in the United States National Museum.

We accept the family of *Chætodontidæ* as limited by Gill and by Jordan & Gilbert, leaving the two genera *Chætodipterus* and *Parapsettus* in a separate but closely related family, *Ephippidæ* (= *Drepaninæ*, Klunzinger).

The American *Chætodontidæ* may be referred to three genera, which may be defined as follows :

ANALYSIS OF GENERA OF CHÆTODONTIDÆ.

a. Preopercle unarmed ; dorsal spines not graduated, some of the median spines longer than the last spines ; scales comparatively large ; (young with the *Tholichthys* form)

b. Snout (nasals, palatines, etc) with premaxillaries articular and dentary bones much produced, beak-like ; cleft of mouth, with maxillaries short ; lateral line ceasing under soft dorsal.

c. Dorsal spines 12 or 13 ; soft rays about 20 (19 to 23).

PROGNATHODES, 1.

bb. Snout little if at all produced ; dorsal spines usually 12 to 14 ; anal spines 3

CHÆTODON, 2.

aa. Preopercle armed with a very strong spine at its angle , (young without *Tholichthys* form ?).

d. Dorsal spines 8 to 14 , vertical limb of preopercle above spine armed or unarmed

POMACANTHUS, 3.

Genus I. PROGNATHODES.

PROGNATHODES Gill, Proc. Ac. Nat Sci Phila , 1862, 238 (*pelta*) (name only.)

Type *Chelmo pelta* Günther, (= *Chelmo aculeatus* Poey.).

This genus, containing two species, *P. longirostris* and *P. aculeatus,* seems to be intermediate between *Chelmon* and *Chætodon,* having the produced snout of the former and a fin-formula more like that usually seen in the latter. Its value as a genus is doubtful, its species differing less from those of *Chelmon* than extreme forms of *Chætodon* differ from each other. Its two species are, moreover, very distinct. the one (*longirostris*) having small scales and a very long beak, while the other (*aculeatus*), has the scales large, and the beak not very much longer than in some species properly referred to *Chætodon.*

ANALYSIS OF SPECIES OF PROGNATHODES

a. |Snout moderately produced, about half length of head ; profile steep, concave. Maxillary reaching to middle of snout Angle of preopercle rounded, minutely serrate. Dorsal spines long and very strong , 4th spine 2 in depth ; membrane between spines deeply notched. Soft anal higher than soft dorsal ; their basal halves

alone scaled Caudal truncate; uniform reddish brown, with shining longitudinal streaks, following the series of scales; spinous dorsal and its base blackish; soft dorsal bordered with orange, other fins yellowish or colorless; border of opercle orange; ocular band dark, narrower than eye, without paler border, not extending below eye. D. XIII, 19; A. III, 15; Scales 8–40–19 Depth 2 in length; head 3.] (*Gunther, Poey*)

ACULEATUS, 1.

1. PROGNATHODES ACULEATUS.

Chelmon aculeatus Poey, Memorias, II, 202 (July, 1860). (Havana.)
Prognathodes aculeatus Poey, Synopsis, 1868, 354; Poey, Enumeratio, 1875, 63 (Cuba)
Chelmo pelta Günther; Cat. Fish Brit. Mus., II, 38 (September, 1860). (Locality unknown)

Habitat. West Indian Fauna.

This species is known to us only from the accounts of Günther and Poey.

Genus 2. CHÆTODON.

CHÆTODON Artedi, Genera, 1738, 51, Synonymia, 1738, 89 (numerous species, many belonging to *Pomacanthus*, etc.)

TETRAGONOPTRUS Klein, Historia Piscium, 1744, 37 (ma y species, *striatus*, etc.)

CHÆTODON Linnæus, Systema Naturæ, X, 1758, 272 (includes the then known *Chætodontidæ*, some *Acanthuridæ*, etc.)

CHÆTODON Cuvier, Règne Animal, ed. II, 1827 (*striatus*, *capistratus*, etc.).

RABDOPHORUS Swainson, Fish., Rept., and Amph., 1839, II, 21 (*ephippium*).

CITHARŒDUS Kaup, "Wiegm. Arch., 1860 (*meyeri*)"

ETEIRA Kaup, "l. c (*triangularis*=*strigangulus*)"

LINOPHORA Kaup, "l. c (*auriga*).

SAROTHRODUS Gill, Proc Ac. Nat. Sci. Phila., 1862, 238 ("Chætodon Cuv., nec Artedi" substitute for *Chætodon*, transferred to *Pomacanthus*)

THOLICHTHYS Günther, Ann. Mag. Nat. Hist., London, 1868, 457 (*osseus*, larval form).

TETRAGONOPTRUS Bleeker, Rev. Famille Chætodontoides, 1877, 52 (*striatus*).

CHÆTODONTOPS Bleeker, l. c., 53 (*collaris*).

HEMICHÆTODON Bleeker, l. c., 53 (*capistratus*).

LEPIDOCHÆTODON Bleeker l. c., 54 (*unimaculatus*).

OXYCHÆTODON Bleeker l. c., 54 (*lineolatus*).

GONOCHÆTODON Bleeker l. c., 54 (*triangulum*)

CHÆTODON Jordan & Gilbert, Synopsis Fish. North America, 1883, 614 (*capistratus*).

ANISOCHÆTODON Klunzinger, Fische des Rothen Meeres, 1884, 54 (*auriga*, etc.).

Type, *Chætodon capistratus*.

As the first species enumerated under *Chætodon* by Artedi, belongs to the modern genus *Pomacanthus*, Bleeker, Gill and Poey have transferred the name *Chætodon* to the latter group. The present genus is therefore called by Gill, *Sarothrodus*, and by Bleeker, *Tetragonoptrus*, the latter name being taken from Klein.

If, however, our generic nomenclature is to date from 1758, this change is inadmissable. The *Chætodon* of Linnæus practically corresponded to the modern family of *Chætodontidæ*. It was first restricted by Cuvier to species of the type of the Linnæan species, *striatus*, *capistratus*, etc., and with this group the name must remain. The selection of *capistratus* as the actual type of the genus dates from the work of Jordan & Gilbert.

Very young forms of Chætodon, which are provided with large flat, membranous, scale-like, expansions or shields developed from the bones about the head (preoperclc, shoulder-girdle, etc.), have been described under the generic name of *Tholichthys*. The true character of *Tholichthys* as a larval *Chætodon*, has been shown by Dr. Lütken (Spolia Atlantica).

The species of *Chætodon* are very numerous, and abound in all tropical seas about the coral reefs.

ANALYSIS OF NORTH AMERICAN SPECIES OF CHÆTODON.

Scales of trunk all subequal, with their posterior margins regularly rounded.

b. Series of scales below the axis of the body running obliquely upward and backward. (*Chætodontops* Bleeker.)

c. [Ocular band extending from dorsal *only to eye*, not across the cheek; snout little produced, its length less than diameter of eye; body deep, the height 1⅝ in extreme length; muzzle with a blackish band; a transverse band between eyes, much narrower than eye, a band between dorsal fin and interorbital area, descending to temples and bordered with whitish; another crosses dorsal fin, caudal peduncle, and near margin of anal, the anterior margin of which extends from the base of the anterior soft rays to axilla of anal fin; caudal, produced part of dorsal, margin of anal, and all of pectoral and ventral fins pale. D. XII, 24, A. III, 20. Scales 44] (*Gill.*) NIGRIROSTRIS, 2.

cc. Ocular band extending beyond the eye across the cheek and interopercle; no transverse band between the eyes

d. A large black spot, not ocellated, on base of soft dorsal; an indistinct band extending vertically across from it to base of anal; a small black spot on tip of soft dorsal (obsolete in young), ocular band narrower than eye, extending from in front of dorsal through eye and over interopercle, no humeral band; a black spot on opercle above, body subrhomboidal; the anterior profile concave; snout somewhat produced, longer than eye. Lateral line extending to below posterior third of sott dorsal Dorsal and anal fins angular behind, depth 1½ in length; head 3. D. XIII (or XII), 20, A III, 16 Scales 6–34–15; (31 in a median series).

OCELLATUS, 3.

dd. No spot at base of soft dorsal, dorsal and anal rounded behind *

e. Humeral band wanting

f. Ocular band jet black, not white edged, little narrower than eye, extending from first and second dorsal spine through eye and over cheek; another band from fourth and fifth dorsal spines to base of posterior half of anal, not extending on anal; a dark line from dorsal down the middle line of forehead; rest of body yellowish without markings. Body deep, strongly compressed; snout somewhat produced, 2½ in head, forming an angle with the descending profile; second dorsal spine highest, as long as head; caudal rounded. Lateral line extending to below first dorsal ray, depth 1⅝ in length (2 in total), head 2½ (3); D. XII, 18; A. III, 17 Scales 9–36–17. AYA, 4

ff. [*Ocular band edged with whitish,* narrower than eye, continued across interopercle, a brown, white-edged vertical band from extremity of dorsal across tail over posterior half

* This character has not been verified in *Chætodon aya.*

of soft anal ; fins and body otherwise chiefly pale. Body deep, the back elevated ; snout subconical, somewhat produced, as long as eye. Depth 2 in total length ; head 4. D. XII, 23 ; A. III, 19 ; scales 7–38–17.] (*Poey, Günther.*)

SEDENTARIUS, 5.

cc. Humeral band present, black, broader than eye, extending from front of spinous dorsal to base of pectoral ; ocular band narrower than eye, extending from in front of dorsal across eye and over cheek and interopercle ; a broad band from last dorsal spines to base of anal ; soft dorsal and anal with a dark band parallel with the margin ; three dark bands across caudal fin and peduncle. Body deep, the back elevated, the profile steep and concave ; snout very slightly produced, shorter than eye, which is 3 in head , scales on head small Lateral line extending to below posterior end of soft dorsal. Head 3 in length ; depth $1\frac{1}{8}$ D XIII, 20 ; A III, 17 , scales 6–30–17.

HUMERALIS, 6.

bb. Series of scales below the axis of the body horizontal or very nearly so (*Tetragonoptrus* Bleeker.)

f [Soft dorsal and anal rounded behind; snout slightly produced-very little longer than eye ; body with fine blackish cross, bars, the first an ocular band, narrower than eye, from dorsal through eye and over interopercle , second, a humeral bar from front part of spinous dorsal to ventral region , third, from last five dorsal spines to front of soft anal, curved forwards , fourth curved backwards, from last dorsal spines along whole base of soft dorsal to base of anal , fifth, across middle of caudal fin and extending as a marginal band on soft dorsal and anal : this yellow-edged behind. Ventrals black Young with a black spot ocellated with white on upper part of fourth band D. XII (XI), 21 , A III, 18 ; scales 8–40–16] (*Günther*, etc) STRIATUS, 7

bbb. Series of scales below the axis of the body extending downward and backward (*Chætodon=Hemichætodon* Bleeker)

g Body not very deep, the back not greatly elevated, the anterior profile concave · snout somewhat produced, as long as the eye ; soft dorsal and anal fins angulated behind. Dorsal spines rather slender Scales rather large, their arrangement peculiar, those above the level of the upper part of the eye, placed in straight series which run upward and backward, those below this line running similarly downward and backward ; each series of scales being sharply marked by a continuous blackish streak, underneath the scales. Ocular band edged with pale, much narrower than eye, and extending

across eye and cheek; a very large jet-black spot, ocellated with pale, below soft dorsal; soft dorsal and caudal with two narrow black bands, the margin abruptly pale. Head $3\frac{1}{4}$; depth $1\frac{1}{2}$. D. XIII (XII), 19; A. III, 17. Scales 6–42–17

CAPISTRATUS, 8.

2. CHÆTODON NIGRIROSTRIS.

Sarothrodus nigrirostris Gill, Proc. Ac. Nat. Sci. Phil., 1862, 243 (Cape San Lucas).

Chætodon nigrirostris Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 365 (Cape San Lucas); Jordan, Cat. N. A. Fishes, 102, 1885 (name only).

Habitat, Cape San Lucas.

This species is known to us only through the descriptions of Gill. The original types alone have been taken.

3. CHÆTODON OCELLATUS.

Chætodon ocellatus Bloch, Ichthyologia, taf. 211, fig 2, 1787; Walbaum, Artedi, Genera, 414, 1792 (copied); Turton, Syst. Nat., I, 777, 1806 (India); Jordan, Cat Fish North America, 102, 1885 (name only).

Chætodon bimaculatus Bloch, Ichthyologia, taf. 219, fig. 1, 1790, Walbaum, Artedi, Genera, 415 1792 (copied), Cuvier & Valenciennes, Hist Nat Poiss., VII, 67, 1831 (Havana, Martinique, Porto Rico, San Domingo), Storer, Syn Fish N. A., 338, 1845 (copied); Poey, Mem. de Cuba, II 371, 1860 (Cuba), Günther, Cat. Fish Brit. Mus., II, 9, 1860 (Jamaica; Poey, Enum Pisc. Cub., 62, 1875 (Cuba); Jordan & Gilbert, Syn. Fish N A, 940, 1882.

Sarothrodus bimaculatus Cope, Trans Am. Phil Soc., 1870, 474 (Santa Cruz); Poey, Enum Pisc. Cub., 62, 1875 (Cuba), Goode, Bull. U S Nat Mus, V, 43, 1876 (Bermudas).

Sarothrodus maculocinctus Gill, Proc. Ac. Nat Sci. Phil., 99, 1861 (Newport).

Chætodon maculocinctus Jordan & Gilbert, Syn Fish N A., 616, 1882.

Sarothrodus amplexicollis Poey, Enum Pisc. Cub., 63, 1875 (Cuba)

Habitat, West Indian Fauna; India.

The numerous specimens examined by us are from Havana. There is no doubt that *Sarothrodus maculocinctus* from the Gulf Stream, is the young of this common tropical species.

4. CHÆTODON AYA.

Chætodon aya Jordan, Proc. U. S. Nat. Mus., 1886, 225 (Snapper Banks near Pensacola, Fla).

Habitat, Northern Gulf Coast of Florida; Pensacola.

We have examined the original type of this species, which is now in the United States National Museum (No. 37747); length 1½ inches. The description given here is that of the young; the adult will probably be found to vary somewhat from the proportions given here.

5. CHÆTODON SEDENTARIUS.

Chætodon sedentarius Poey, Mem. de Cuba, II, 203, 1858 (Cuba).

Sarothrodus sedentarius Poey, Syn. Pisc. Cub., 364, 1868 (Cuba); Poey, Enum. Pisc. Cub., 62, 1875 (Cuba).

Chætodon gracilis Günther, Cat. Fish. Brit. Mus., II, 20, 1860 (Caribbean Sea; West Indies).

Habitat, West Indian Fauna.

This species is known to us only through descriptions.

6. CHÆTODON HUMERALIS.

Chætodon humeralis Günther, Cat. Fishes Brit. Mus., II, 19, 1860 (Sandwich Islands); Günther, Fishes Central America, 419, pl. 65, f. 3, 1866 (Pacific Coast Central America).; Jordan, Cat. Fishes N. A., 102, 1885 (name only).

Habitat, Pacific Coast of Central America.

The specimens examined by us are from Colima, on the West Coast of Mexico. The occurrence of this species at the Sandwich Islands is questionable.

7. CHÆTODON STRIATUS.

Chætodon No. 7, Artedi, Syn. 95; No. 10, Succi Descr. Spec. Pisc., 80, 1738.

Labrus rostro reflexo fasciis lateralibus tribus fuscis, Linnæus, Amœn. Ac. I, 595, 1749.

Chætodon striatus Linnæus, Syst. Nat., ed. X, 275, 1758 (India); *id.* ed. XII, 464, 1766; Bloch, Ichthyologia, plate 205, fig. 1, 1787; Gmelin, Syst. Nat., I, 1249, 1788 (India); Bloch & Schneider, Syst. Ichth., 222, 1801 (East Indies); Turton, Linnæus, Syst. Nat., I, 772, 1806 (India); Cuvier & Valenciennes, Hist. Nat. Poissons, VII, 10 (San Domingo, Martinique, St. Thomas); Storer, Syn. Fish. North Am., 338, 1845 (copied); Gronow, Cat. Fish. Brit. Mus., 68, 1854 (Indian Sea); Poey, Mem. de Cuba, II, 371, 1860 (Cuba); Castelnau, "Anim. Amer Sud Poiss., 19," 1850, 61; Günther, Cat. Fish. Brit. Mus., II, 8, 1860 (Puerto Cabello, Venezuela, St. Domingo, Jamaica).

Sarothrodus striatus Poey, Syn. Pisc. Cub., 352, 1868 (Cuba); Poey, Enum. Pisc. Cub., 62, 1875 (Cuba).

Habitat. West Indian Fauna and India.

Known to us through descriptions and plates only.

8. CHÆTODON CAPISTRATUS.

Labrus rostro reflexo ocello purpureo iride alba juxta caudam. Linnæus, Amœn. Ac. I, 596, 1749.

Chætodon capistratus Linnæus, Syst. Nat., ed. X, 275, 1758 (India); Linnæus, Syst. Nat., ed. XII, 465, 1766 (India); Bloch, Ichthyologia, tab. 205, fig. 2, 1787; Gmelin, Syst. Nat., 1250, 1788 (Jamaica); Walbaum, Artedi, Syn., 414, 1792 (Jamaica); Bloch & Schneider, Syst. Ichth., 222, 1801 (Indian Sea); Turton, Linnæus, 772, 1806 (Jamaica); Risso, "Eur. Merid., III, 432," 1827; Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 64, 1831 (Martinique, San Domingo, St. Thomas, Cuba); Gronow, Cat. Fish. Brit. Mus., 67, 1854 (American Seas); Günther, Cat. Fish. Brit. Mus., II, 12, 1860 (Jamaica, Puerto Cabello, Demarara, Trinidad); Jordan & Gilbert, Syn. Fish. North America, 940, 1883; Jordan, Cat. Fishes North America, 102, 1885 (name only).

Sarothrodus capistratus Poey, Enum. Pisc. Cub., 62, 1875 (Cuba).

Habitat, Indian and West Indian Fauna.

The specimens examined by us are from Havana. It is a common fish of the West Indian fauna.

Genus 3. POMACANTHUS.

POMACANTHUS Lacépède, Hist. Nat. Poiss., IV, 517, 1803 (*grison*).
HOLACANTHUS Lacépède, Hist. Nat. Poiss., IV, 525, 1803 (*tricolor*, etc.).
GENICANTHUS Swainson, Fish. Amphib. & Rept., II, 212, 1838 (*lamarckii & tricolor*)

CENTROPYGE Kaup, Wiegm. Arch., XXVI, 1, 1876, 138 (*tibicen*).

POMACANTHODES Gill, Proc. Acad. Nat. Sci. Phila., 1862, 244 (*zonipectus*).

ACANTHOCHÆTODON Bleeker, "Arch. Néerl. Sc. Nat., XII, 5," 1876 (*lepidolepis*).

CHÆTODON Bleeker, l. c. (transferred to species of *Pomacanthus*, as the first species of *Chætodon* mentioned by Artedi belongs to the latter group).

Type, *Pomacanthus grison.*

Lacépède based his genera *Pomacanthus* and *Holacanthus* on the armature of the preopercle. This character is not sufficient to separate the species of this group into two genera, because, 1st: The armature varies in the species of *Holacanthus* from minute serræ (*passer* and *tricolor*) to a number of strong spines (*ciliaris*); 2nd: The upper limb of the preopercle, in the young at least of some species otherwise resembling *Pomacanthus* (*zonipectus*), is armed with minute serræ. We have therefore placed those species having a spine at the preopercle and the dorsal spines graduated, in the genus *Pomacanthus*, regardless of the armature of the upper limb of the preopercle. The degree of the graduation of the dorsals might offer some distinctive characters; the species of *Pomacanthus* proper, having each succeeding spine decidedly higher than the one preceding it. But here again we find variation in the species of *Holacanthus*: the spines of *H. tricolor* are all of about the same hight, with the exception of the last two or three, while in *H. ciliaris* the spines are regularly graduated, though the last spine does not attain the hight that the spines in the species of *Pomacanthus* do. The subdivision adopted by Dr. Günther, although natural enough, does not seem very scientific,—the species with 8 to 10 spines being placed in *Pomacanthus*, while those with 12 or more constitute the genus *Holacanthus*. One species properly belonging to the former group has 11 spines.

ANALYSIS OF NORTH AMERICAN SPECIES OF POMACANTHUS.

a. Dorsal spines 8 to 11; dorsal rays 23 to 32; scales of different size, the longitudinal and cross series not distinct:

b. Scales of the lateral line 50 to 55. Dorsal spines 9 (rarely 8); soft rays 30 to 32; anal rays III, 24. Color in the adult steel-gray. The larger scales surrounded by smaller ones; each scale with a dark spot at base; older specimens nearly plain yellowish.

young with about 4 whitish cross-bands ; caudal truncate, with a pale edge ; base of pectoral without orange. Depth $1\frac{1}{3}$ in length, head $3\frac{1}{2}$. Scales 8–53–27. First dorsal spine about 5 in the length of the last, which is $1\frac{1}{5}$ to $1\frac{1}{3}$ in head.

AUREUS, 9.

bb. Scales of the lateral line 70 to 90.

c. Dorsal spines usually 10 ; the soft rays 29 to 30. Anal rays III, 23 to 24. Color black ; scales of different sizes on the body, most of them with yellow edge ; young with yellowish cross-bands ; base of pectoral orange ; caudal rounded, its border not pale ; 65 scales in a median series ; 85 to 90 in the series above the lateral line. ARCUATUS, 10.

cc. [*Dorsal spines 11, soft rays 23 ; anal rays III, 20 to 22.* Profile very steep, uneven ; vertical limb of preopercle with minute serræ, at least in young ; spine at angle of opercle about as long as eye. Soft rays of anal lower than those of dorsal. Soft dorsal highest toward the front, the rays more rapidly shortened posteriorly than those of anal. Caudal somewhat rounded , Ventrals elongate, reaching 3rd anal spine, the first ray filamentous. Scales of body irregular in size, large and small ones closely intermixed ; scales ot head, breast, and front of back very small Color brownish, a broad dark band girding the breast and extending up to 5th dorsal spine Young pure black on dorsal and anal Top of head with a median line of bright yellow, dividing at the snout, extending along each side of mouth and meeting on throat below. Sides with five very distinct narrow bright yellow cross-bars, strongly convex forward , blue lines between bars. Depth $1\frac{1}{2}$ in length , head $3\frac{1}{2}$. Scales in lateral line 70.] (*Jordan & Gilbert, Gill*)

ZONIPECTUS, 11

aa. Dorsal spines 14, dorsal rays 17 to 20 ; scales all of about the same size, the rows lengthwise and crosswise quite distinct.

d. Ascending limb of preopercle armed only with small serræ the largest not more than $\frac{1}{15}$ the length of the large spine at the angle, which is about $2\frac{1}{2}$ in head

e. [*Scales in lateral line 75 to 80 ; the angles of the caudal not produced into filaments ; preorbital with two or three blunt points.* Color brown, with a transverse white band from the sixth dorsal spine ; caudal, ventral, pectoral, and margin of anal fins yellow. Head with two distinct bluish bands, one in front of eyes, one from front of dorsal behind the eye. Depth $2\frac{1}{4}$ in length ; head 4. D. XIV, 17 or 18 ; A. III, 16–18.] (*Valenciennes,* etc.) PASSER, 12.

ee. Scales in lateral line 48; the angles of the caudal produced into filaments; preorbital with a distinct blunt spine. Color in life: head, anterior part of trunk and caudal fin, golden yellow; rest of body, snout and chin, black: dorsal, anal and opercle edged with scarlet; orange on upper and lower ray of caudal; iris yellow, blue above and below. Depth 1⅗ in length; head 3½. D. XIV, 19: A. III, 18. Scales 8–48–25. First dorsal spine 1½ in length of the last, which is 2½ in head. TRICOLOR, 13.

dd. Ascending limb of preopercle armed with 3 to 9 strong spines, the largest about ⅛ the length of the large spine at the angle, which is 3½ to 4½ in head; caudal obliquely rounded; its angles not produced; angle of dorsal and anal very much produced, their tips extending beyond caudal; preorbital without a distinct spine Color in life: yellowish brown on sides, each scale with a darker or orange spot; back shaded with violet, which grows brighter and merges into intense sky-blue along the edges of the spinous dorsal and on the region before the dorsal; scales of dorsal region with brown spots like those on sides, head paler; the upper lips yellowish, lower jaw reddish; spines of preopercle and edge of opercle very bright sky-blue; iris yellow, marked above and below by blue, a blue bar extending from in front of first dorsal spine half way to eye, breast a sky-blue; pectorals sky blue at base, then broadly golden, its edge pale; ventrals golden; posterior edge and produced lobe of dorsal and anal golden yellow, caudal broadly edged with yellow Depth 1½ to 1⅔ in length; head 3½ to 3⅜ D XIV, 20. A III, 18. Scales 8–45–28. First dorsal spine about 2½ in the length of the last, which is 2⅓ in head. Vertebræ 10+14 CILIARIS, 14.

9. POMACANTHUS AUREUS

Chætodon aureus Bloch, Ichthyologia. taf. 193, fig. 1, 1787. Walbaum, Artedi Genera, 407, 1792 (copied); Bloch & Schneider Syst. Ichth., 217, 1801 (Antilles); Turton, Linnæus Syst Nat, I, 773, 1806 (copied), Poey, Syn. Pisc Cub., 350, 1868 (Cuba).

Pomacanthus aureus Lacépède, Hist. Nat. Poiss. IV, 1802 (Brazil); Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 202, 1831 (St Thomas, San Domingo): Storer, Syn. Fish. N. A., 340, 1845 (copied): Poey, Mem. de Cuba, II. 371, 1860 (Cuba); Jordan, Proc. U. S. Nat Mus, 1884, 131 (Key West); Jordan, Cat. Fish. North America, 1885, 103 (name only).

Chiririta Parra, Descr. Dif. Piez. Hist Nat. Cub., 10, plate 6, fig. 2, 1787 (Cuba)

Pomacanthus arcuatus Bloch, Ichthyologia, taf 201, fig. 2, 1887; Bloch & Schneider, Syst. Ichth., 218, 1801; Lacépède, Hist. Nat. Poiss., IV, 1802 (after Bloch).

Pomacanthus balteatus Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 208, 1831 (Porto Rico); Storer, Syn. Fish. N. A., 1845, 340 (copied).

Pomacanthus paru Günther, Cat. Fish. Brit. Mus., II, 55, 1860 (in part), (West Indies).

Chætodon arcuatus Poey, Syn. Pisc. Cub., 351, 1868 (Havana).

Pomacanthus arcuatus Jordan & Gilbert, Syn. Fish. North America, 616, 1883; Baird, Bull U. S. Fish. Com., 1884, 178 (Barnegat City, N. J.).

Habitat, West Indian Fauna north to New Jersey.

The many specimens examined are from Havana.

There is considerable difficulty in distinguishing the synonymy of this species from that of *arcuatus*; the differences between the two species are those set forth in the Key; but the descriptions and figures often contain elements from both species, on account of the similarity of coloration in the young. *Pomacanthus arcuatus* Bloch, belongs here, having nine dorsal spines, the caudal white-edged but rounded. *Chætodon arcuatus* Poey, and *Pomacanthus arcuatus* Jordan & Gilbert, are placed here on the authority of those authors

10. POMACANTHUS ARCUATUS.

Paru Brasiliensibus Marcgrave, Hist Pisc., Lib I, 144, 1648 (Brazil)

Guaperua Brasiliensibus Marcgrave, Hist Pisc, Lib. I. 178, 1648 (Brazil)

Chætodon No. 3, Artedi, Syn. 91, 1738.

Chætodon No. 4, Brown "Jamaica, 454," 1756 (Jamaica).

Chætodon arcuatus Linnæus, Syst. Nat, ed X, 273, 1758 (Indies), same, ed. XII, 462, 1766 (Indies); Turton, Linnæus Syst. Nat., I, 769, 1806 (copied); Bleeker, Arch. Néerl. Sci. et Nat., XI, 181, 1876 (Surinam, Hayti, Santa Cruz).

Chætodon lutescens Bonnaterre, "Planche de l'Encyclopédie Methodique, 182," 1782.

Pomacanthus lutescens Lacépède, Hist. Nat. Poiss, IV, 518, 1802 (after Brown),

Chætodon paru Bloch, Ichthyologia, taf. 197, fig 1, 1787; Bloch & Schneider, Syst. Ichth., 217, 1801; Gmelin, Syst. Nat., 1256, 1788 (copied); Turton, Linnæus Syst. Nat., I, 774, 1806 (South America); Poey, Syn. Pisc. Cub., 351, 1868 (Havana).

Pomacanthus paru Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 205, 1831 (Martinique); Günther, Cat. Fish. Brit. Mus., II, 55, 1860 (Bahia, Puerto Cabello, Jamaica), [in part].

Chiririta Parra, Descr. Dif. Piez. Hist. Nat. Cuba, 9, plate 6, fig. 1, 1787 (Cuba).

Pomacanthus cingulatus Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 209, 1831; Castelnau, "Anim nouv. ou rares de l'Amer. du Sud, Poiss., 20," 1855.

Pomacanthus quinquecinctus Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 210, 1831 (locality ?); Castelnau, "Anim nouv. ou rares de l'Amer. du Sud, Poiss., 20," 1855.

Chætodon quinquecinctus Poey, Syn. Pisc. Cub., 351, 1868 (Cuba).

Pomacanthus arcuatus Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 211, 1831 (locality ?); Lütken, Spolia Atlantica, 61, 1880; Castelnau, "Anim. nouv. ou rares de l'Amer. du Sud, Poiss., 20," 1855.

Chætodon littoricola Poey, Syn. Pisc. Cub., 351, 1868 (Cuba); Poey, Enum. Pisc. Cub., 60, 1875 (Cuba).

Habitat, West Indian Fauna south to Bahia.

Known to us only through descriptions and figures.

11. POMACANTHUS ZONIPECTUS.

Pomacanthodes zonipectus Gill, Proc. Ac. Nat Sci Phil., 1862, 244 (San Salvador); the same, 1863, 162 (W. coast Central America).

Pomacanthus zonipectus Jordan & Gilbert, Proc U. S. Nat. Mus., 1882, 376 (Nicaragua, San Salvador); Jordan, Proc U. S. Nat Mus, 1885, 386 (Mazatlan, Panama); Jordan, Cat. Fishes N. A., 1885, 103 (name only)

Pomacanthus crescentalis Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 358 (Mazatlan Harbor and Panama). (Young of *zonipectus*.)

Habitat, West coast of tropical America.

This species is known to us only through descriptions. The young, quite unlike the adult in color, were at first taken by Jordan & Gilbert for a distinct species.

12. POMACANTHUS PASSER.

Holacanthus passer Valenciennes. Voyage Venus, 327, pl. 6, 1831 (Galapagos Archipelago); Günther, Cat. Fishes Brit. Mus., II, 46, 1860 (copied).

Holacanthus strigatus Gill, Proc. Ac. Nat. Sci. Phil., 1862, 248 (Cape San Lucas); Jordan, Cat. Fishes North America, 108, 1885 (name only); Jordan, Proc. U. S. Nat. Mus., 1885, 385 (Cape San Lucas, Colima).

Pomacanthus strigatus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 353 (Cape San Lucas); Jordan & Gilbert, the same, 1884, 365 (Cape San Lucas); Jordan & Gilbert, the same, 1884, 372 (Colima).

Habitat, West coast Central America and Galapagos Islands.

We have not seen this species.

There seems to be little doubt that *Holacanthus strigatus* is the young of *Holacanthus passer.*

13. POMACANTHUS TRICOLOR.

Catalineta. Parra, Descr. Dif. Piez. Hist. Nat. Cuba, 12, lam. VII, f. 2, 1787 (Cuba).

Acarauna Edwards, "plate 283, fig 4."

Chætodon tricolor Bloch, Ichthyologia, taf 426, 1795; Bloch and Schneider, Ichth., 219, 1801 (Brazil and Havana)

Holacanthus tricolor Lacépède, Hist Nat. Poiss, 10, 525, 1803 (Brazil, Guadaloupe, Cuba); Cuvier & Valenciennes, Hist Nat Poiss., VII, 162, 1831 (St. Thomas); Storer, Syn Fishes North America, 340, 1845 (copied), Poey, Mem. Cuba, II, 371, 1860 (Cuba), Günther, Cat. Fishes Brit. Mus, II, 49, 1860 (Bahia, West Indies, Jamaica, Trinidad); Poey, Enumeratio, 61, 1875; Goode, Bull U. S. Nat. Mus., V, 44, 1876 (Bermudas).

Genicanthus tricolor Swainson, Fishes, Amphibians, and Reptiles, II, 212, 1839 (name only).

Pomacanthus tricolor Jordan & Gilbert, Syn. Fishes North America, 941, 1882.

Habitat, West Indian fauna south to Bahia.

The single specimen of this species examined is from Havana. Its synonymy offers no difficulty.

14. POMACANTHUS CILIARIS

Acarauna major pinnis cornutis, an Paru Brasiliensibus (the Angel-fish,) Catesby, Nat. Hist. Car., Fla., and Bahama Is., 1731, plate 31.

Chætodon ciliaris Linnæus, Syst. Nat., ed. X, 276, 1758 (Indies) (in part); Linnæus, Syst. Nat., ed. XII, 1766; Bloch, Ichthyologia, taf. 214, 1787; Gmelin, Syst. Nat., 1252, 1788 (copied); Bloch & Schneider,

Syst. Ichth., 218, 1801 ; Turton, Linnæus Syst. Nat., I, 778, 1806 (copied) ; Walbaum, Artedi Pisc., 419, 1806 (copied).

Holacanthus ciliaris Lacépède, Hist. Nat. Poiss., IV, 527, 1802 (Indies) ; Cuvier & Valenciennes, Hist. Nat. Poiss., VII, 154, 1831 (Gulf of Mexico) ; Storer, Syn. Fishes N. A., 339, 1845 (copied) ; Poey, Mem. de Cuba, II, 371, 1860 (Cuba) ; Günther, Cat. Fishes Brit. Mus., II, 46, 1860 (Bahia, West Indies, Jamaica) ; Gill, Cat. Fish. East Coast N. A., 34, 1861 (name only) ; Poey, Syn. Pisc. Cub., 351, 1868 (Cuba) ; Gill, Cat. Fish East Coast N. A., 24, 1873 ; Goode, Bull. U. S. Nat. Mus., V, 43, 1876 (Bermudas) ; Lütken, Spolia Atlantica, 200, 1880 (Antilles) ; Jordan, Proc. U. S. Nat. Mus., 1884, 131 (Key West) ; Jordan, Cat. Fishes North America, 103, 1885 (name only .

Pomacanthus ciliaris Jordan and Gilbert, Syn. Fishes North America, 615, 1882 (West Indies, South Atlantic coast).

Isabelita "Parra, Descr. Dif. Piez. Hist. Nat Cuba, pl. 7, f. 1," 1787 (Cuba).

Chætodon parræ Bloch and Schneider, 235, 1801 (after Parra)

Holacanthus parræ Poey, Enum. Pisc. Cub., 61, 1875 (Cuba).

Chætodon squamulosus Shaw, "Naturalists' Miscellany," 180 ?, 275 (after Catesby).

Holacanthus cornutus Demarest, Decade Ichthyologique, 44, pl. 8, f. 3, 1823 (Cuba).

Chætodon aculeatus Gronow, Cat. Fishes Brit Mus , 73, 1854.

Holacanthus formosus Castelnau, "Anim. nouv. ou rares de l'Amer du Sud, Poiss., 19, pl. 11, f. 2," 1855 (fide Lütken) ; Günther, Cat. Fish. Brit. Mus , II, 47, 1860 (Sea of Bahia)

Habitat, West Indies.

Our specimens of this species are from Key West, Florida. It is a common member of the West Indian fauna.

A List of the Nominal Species of American Chætodontidæ in Chronological Order, with Identifications.

(Tenable specific names in *italics.*)

Nominal Species.	Author.	Date	Identification
Chætodon *arcuatus*	Linnæus	1758	Pomacanthus arcuatus.
Chætodon *striatus*	Linnæus.	1758	Chætodon striatus.
Chætodon *capistratus*	Linnæus	1758	Chætodon capistratus
Chætodon *ciliarus*	Linnæus.	1758	Pomacanthus ciliaris.
Chætodon lutescens	Bonaterre.	1782	Pomacanthus arcuatus.
Chætodon paru	Bloch.	1784	Pomacanthus arcuatus.
Chœtodon *aureus*	Bloch	1787	Pomacanthus aureus
Chætodon *ocellatus*	Bloch.	1787	Chætodon ocellatus
Chætodon bimaculatus	Bloch.	1790	Chætodon ocellatus
Chætodon *tricolor*	Bloch.	1795	Chætodon tricolor.
Chætodon parræ	Bloch & Schneider.	1801	Pomacanthus ciliaris.
Chætodon squamulosus	Shaw.	180?	Pomacanthus ciliaris.
Holacanthus cornutus	Demarest.	1823	Pomacanthus ciliaris.
Pomacanthus balteatus	Cuvier & Valenciennes.	1831	Pomacanthus aureus.
Pomacanthus cingulatus	Cuvier & Valenciennes.	1831	Pomacanthus arcuatus.
Pomacanthus quinquecinctus	Cuvier & Valenciennes.	1831	Pomacanthus arcuatus.
Holacanthus *passer*	Valenciennes.	1831	Pomacanthus passer
Chætodon aculeatus	Gronow	1854	Pomacanthus ciliaris.
Holacanthus formosus	Castelnau.	1855	Pomacanthus ciliaris.
Chætodon *sedentarius*	Poey.	1858	Chætodon sedentarius.
Chelmon *aculeatus*	Poey.	1860	Prognathodes aculeatus
Chætodon humeralis	Günther	1860	Chætodon humeralis.
Chætodon gracilis	Günther.	1860	Chætodon sedentarius.
Chætodon pelta	Günther.	1860	Prognathodes aculeatus
Sarothrodus maculocinctus	Gill.	1861	Chætodon ocellatus.
Sarothrodus *nigrirostris*	Gill.	1862	Chætodon nigrirostris.
Holacanthus strigatus	Gill.	1862	Pomacanthus passer.
Pomacanthus *zonipectus*	Gill.	1862	Pomacanthus zonipectus.
Chætodon littoricola	Poey.	1868	Pomacanthus arcuatus.

Nominal Species	Author.	Date.	Identification.
Sarothrodus amplecticollis	Poey	1868	Chætodon ocellatus.
Pomacanthus crescentalis	Jordan & Gilbert.	1881	Pomacanthus zonipectus.
Chætodon *aya*	Jordan.	1886	Chætodon aya

We have in this paper admitted 3 genera and 14 species of North American Chætodontidæ. The list of the genera and species is here repeated, and the general distribution indicated by the letters—

W. West Indian fauna.
P. Tropical fauna of the Pacific coast.
S. Atlantic coast of South America.

Genus I. PROGNATHODES Gill.

1. Prognathodes aculeatus Poey. (W.)

Genus II. CHÆTODON Linn.

§ CHÆTODONTOPS Bleeker.

2. Chætodon nigrirostris Gill (Cape San Lucas).
3. Chætodon ocellatus Bloch (W. Indies).
4. Chætodon aya Jordan (Pensacola).
5. Chætodon sedentarius Poey (W.).
6. Chætodon humeralis Günther (P.).

§ TETRAGONOPTRUS Bleeker.

7. Chætodon striatus Linnæus (W.).

§ HEMICHÆTODON Bleeker.

8. Chætodon capistratus Linnæus (W.)

Genus III. POMACANTHUS Lac.

9. Pomacanthus aureus Bloch (W.).
10 Pomacanthus arcuatus Linnæus (P. S.).
11. Pomacanthus zonipectus Gill (P.).
12. Pomacanthus passer Valenciennes (P.).
13. Pomacanthus tricolor Bloch (W. S.).
14. Pomacanthus ciliaris Linnæus (W.).

II.—*Supplement to a Catalogue of Chemical Periodicals.**

BY H. CARRINGTON BOLTON.

Read February 21, 1887.

I. ADDENDA TO TITLES.

2. AGENDA DU CHIMISTE. (Established in 1877.)

5. [**b.**] Sachregister zu den drei Jahrgängen 1823, 1824, und 1825 oder Band vii—xv des JAHRBUCHES DER CHEMIE UND PHYSIK. Halle, 1826. 8vo.

13. [**c.**] JUSTUS LIEBIG'S ANNALEN DER CHEMIE UND PHARMACIE. *From* Vol. 173 (1874) *the words* "und Pharmacie" *are dropped.*

14. Tables de la cinquième série des ANNALES DE CHIMIE (1874–1883) dressées par Gayon. 1 vol. 8vo. Paris, 1885.

92. [**b.**] ANNALI DI CHIMICA [etc.]. 80 vols. (I–LXXX), 8vo. Milano, 1845–84.
United with Rivista di chimica medica e farmaceutica *and continued under the title:*

[**c.**] Annali di chimica medico-farmaceutica e di farmacologia. Direttori, P. Albertoni. I. Guareschi; Condirettori, A. Pavesi, G. Colombo. Milano, 1885+

99. JAHRESBERICHT * * * * DER REINEN CHEMIE. 1873–81. 9 vols., roy. 8vo. Tübingen, 1874–83.‖

* Annals N. Y. Academy of Sciences, Vol. III. p. 159 (1885)

149. [**A.**] Répertoire de chimie pure et appliquée, [etc.]. 4 vols., 8vo. Paris, 1858–62.

And simultaneously:

[**C.**] Bulletin des séances de la Société chimique de Paris. publié par Adolphe Wurtz et Felix Le Blanc. 1858–62. 3 vols., 8vo. Paris, 1861–62.

[**C**] *united with* [A] *in* 1863 *and with* [B] *in* 1864 *forming* [**a**] *as given in the Catalogue.*

[**D.**] Table analytique des matières contenues dans le Bulletin de la Société chimique 1re et 2e Séries. 1858 à 1874. et dans les Répertoires de chimie pure et de chimie appliquée; suivie de la Table alphabétique des auteurs dressés par Ed. Willm. 1 vol., 8vo. Paris, 1876.

159. Rivista di chimica, medica e farmaceutica. *United in* 1885 *with* Annali di chimica applicata etc.. *See* 92 **b**.

180. Zeitschrift für physiologische Chemie. Sach-und Namen-Register zu Band I–IV, Strassburg. 1882.

II. NEW TITLES.

183. Bulletin de l'Association des chimistes de sucrerie et de distillerie de France et des colonies. 8vo. Paris, 1883+

184. Bulletin of the Chemical Society of Washington. 2 nos., January '84 to January '87. Washington [D. C.,] 1886–'87.

185. Chemiker (Der) und Drogist. Haupt-Organ für Chemiker, Drogisten, Gewerbtreibende, etc. Herausgegeben von H. Krätzer. 4to. Leipzig, 1885+

186. Chemisch-technischer Central-Anzeiger. Fach- und Handelsblatt für Chemiker, Techniker, Drogisten, Apotheker, Fabrikanten. Central-Insertions-Organ für die ge-

sammten chemischen Industriezweige und deren Hilfsindustrieen. Verantwörtlicher Redacteur, Karl Barthel [*later* Otto Prinz]. Sm. fol. Leipzig, 1883–86+.

187. Deutsche Chemiker-Zeitung. Centralblatt für die chemische Praxis und offentliche Gesundheitspflege. Unter Mitwirkung bewährter Fachgelehrten herausgegeben und redigirt von Breslauer. 4to. Berlin, 1886+

188. Journal (The) of Analytical Chemistry. Edited by Edward Hart. Associate editors, P. W. Shimer [and] John Everman. With the assistance of the following specialists: F. C. Blake, F. W. Clarke, Isaac Ott, V. C. Vaughan, H. W. Wiley. 8vo. Easton, Pa., 1887.

189. Meddelelser fra Carlsberg laboratoriet. Udgifvet ved laboratoriets bestyrelse. 2 vols., 8vo. Christiania, 1885–86+

190. New York Analyst (The). Devoted to the interests of sanitary science, food, medicine and the suppression of adulteration. Edited by Henry Lassing. 18 nos., 4to. New York. 1885

[This is successor to an American reprint of the Analyst published in London, hence the above is styled: "New Series."] *From* No. 19, Oct. 1st, 1885, *continued under the title:*

[**a.**] American Analyst. A popular semi-monthly review devoted to industrial progress, sanitation and the chemistry of commercial products. H. Lassing, editor and publisher. 4to. New York, 1885+

191. Skandinaviens kemisk-tekniske Centralblad for Danmark, Sverige, Norge og Finland. Redigeret af G. A. Schmidt. 4 vols., 8vo. Kjøbenhavn, 1882–85+

192. Supplemento annuale alla enciclopedia di chimica scientifica ed industriale, diretto dal Icilio Guareschi. 3 nos. Torino, 1884—86+

193. TOKYO KAGAKKAI KAISHI. [Editor] J. Sakurai. 6 vols., 8vo. Tokyo. June 1880–86+ [Tokyo Chemical Society's Journal, Tokyo, Japan.]

194. VIERTELJAHRESSCHRIFT ÜBER DIE FORTSCHRITTE AUF DEM GEBIETE DER CHEMIE DER NAHRUNGS-UND GENUSSMITTEL, der Gebrauchsgegenstände, sowie der hierher gehörenden Industriezweige. Unter Mitwirkung von Degener, Hochstetter, P. Lohman, Benno Martiny, Paack, Proskauer, Würzburg, L. Aubry, R. Sendtner, H. Will, von Peters, Weigmann, J. Mayrhofer, E. von Raumer, Röttger, herausgegeben von A. Hilger, R. Kayser, J. König, E. Sell. 8vo. Berlin, 1886+

195. ZEITSCHRIFT FÜR DIE CHEMISCHE INDUSTRIE, mit besonderer Berücksichtigung der chemisch-technischen Untersuchungsverfahren. Herausgegeben von Ferdinand Fischer. Roy. 8vo. Berlin, 1887+

196. ZEITSCHRIFT FÜR PHYSIKALISCHE CHEMIE, Stöchiometrie und Verwandschaftslehre. Herausgegeben von Wilh. Ostwald. Riga und Leipzig, 1887+

III.—*Description of a New Species of Thrush from the Island of Grenada, West Indies.*

BY GEORGE N. LAWRENCE.

Read February 28, 1887

Two specimens, male and female, of the bird now described, were received quite recently from Mr. John G. Wells. He writes about them under date of January 21st, as follows: "I send you per book post, skins of two birds shot in the Parish of St. Andrew a few days ago. I remember shooting one of these birds eight or nine years since, from a flock of six, and at the time I thought them to be migratory, but I am now convinced that they are resident, though not numerous.

"From time to time a 'Spotted Grieve' has been reported to me as being seen, but I could never obtain a specimen until now. I hope the skins will reach you safely, and I shall anxiously await your remarks upon them."

This is a fine new species, and its having escaped discovery so long is remarkable. It is the fourth new species obtained by Mr. Wells, since he commenced sending me birds for identification.

The two sexes are precisely alike in colors and dimensions, and as the female is in much the best condition, I have chosen that as the Type.

Margarops albiventris.

"Thrush? Sp. ?

The Park, St. Andrews, Grenada, Jan. 19, 1887."

Female.—Entire upper plumage of a dark hair-brown, with a dull reddish cast on the rump and upper tail-coverts; tail-feathers blackish-brown, with a patch of white on their inner webs at the end; quills blackish-brown, the outer webs of the secondaries washed with light dull rufous; the ends of the tertials are edged with white; the inner margins of the quills are of a pale salmon color; the greater wing coverts are margined with pale rufous.

white; the feathers of the throat and fore-neck are whitish, with sub-terminal bands and spots of brown; breast, abdomen and under tail-coverts white, having a few feathers edged with brown; sides dull white, the feathers with strongly marked subterminal bands of brown; bill black; tarsi and toes reddish-brown.

Length (fresh) $9\frac{1}{2}$ inches; wing, $4\frac{1}{2}$; tail, $3\frac{3}{8}$; tarsus, $1\frac{1}{16}$.

Habitat, Island of Grenada, West Indies.

Type in National Museum, Washington.

Remarks.—This species, in distribution of colors and character of markings on its under plumage, somewhat resembles *M. montanus*, found in several of the more northerly islands. It is, however, smaller in all its dimensions, and is of a much darker brown above, *montanus* being of a warm brown, much lighter in color; the breast and abdomen are white, sparsely marked with brown spots, whereas in *montanus* a small space only on the middle of the abdomen is of a dull white, and the feathers of the neck in front, the breast, the upper part of the abdomen and the sides are closely marked with subterminal brown bands, giving a general squamiform appearance to the under surface, and making the under plumage of the two species strikingly different.

IV.—*Notes on North American Julidæ.*

BY CHARLES H. BOLLMAN.

Read February 28th, 1887

The following paper is based upon the material of this family embraced in the entomological collection in the Museum of the Indiana University.

In connection with the description of the new species, it has also been deemed best to introduce descriptions of those already known to science.

The types of the new genera and species are deposited in the above museum.

Family A. JULIDÆ Leach.

Genus 1. JULUS Linn.

JULUS Linnaeus, Syst. Nat., Ed X, I. 639, 1758

This genus differs from *Parajulus* in the mandibulary combs being four; the first segment of an equal size in both sexes: the second pair of feet not stunted; and the first pair of the male small, three-jointed, the last joint large and uncinate.

As the subgenera of this genus are very much confused, I have not attempted to give a key to those to which the following species belong.

1. JULUS OWENII, sp. nov.

Pale brown, a lateral series of dark brown spots, first dorsal plate with a brown band along the anterior border; a brown band between the eyes, a pale oval spot at the base of antennæ, feet and antennæ pale Moderately slender, not smooth, not pilose Vertex rough; a faint median sulcus; setigerous foveolæ absent Antennæ subclavate, equal to the width of body. Eyes indistinct, subcircular, ocelli not always filled out, about 28, arranged in 6 or 7 series. Segments 38-

40. First segment unusually thin, advanced forward to the eyes; sides striate. Other segments moderately striate both above and below. Last segment rounded; anal valves not marginate, not pilose; anal scale triangular. Repugnatorial pore moderately large, longitudinally oval, touching the transverse suture, which is excised. Pairs of feet 54-66, rather stout, equaling the width of body. *Male:* mandibulary stipes not much produced beneath. First pair of legs small, strongly uncinate. Genitalia concealed. Length of body 11.4-13.5 mm., width, .7-.8 mm.

Habitat, New Harmony, Indiana.

I have examined two males of this species, collected by Dr. Richard Owen, of New Harmony, Ind., after whom the species is named.

This species belongs to the sub-genus *Allajulus* as defined by Latzel.

2. JULUS VIRGATUS Wood.

Julus virgatus Wood, Proc. Acad. Nat. Sci. Phila., 14, 1864.

Fulvous-brown, a black median and two lateral bands, a dark band between eyes; joints of antennæ tipped with black, feet pale. Slender, nearly smooth: a row of hairs along the posterior border of each segment. Vertex smooth, a faint median sulcus; setigerous foveolæ present. Antennæ moderate, subclavate, equaling width of body. Eyes distinct, triangular or trapezoidal, ocelli 25-40, arranged in 6-7 series. Segments 30-35. Sides of first segment marginate; other segments striate both above and below, but more so in the latter; last segment rather sharply rounded, sparsely pilose, anal valves scarcely marginate, smooth, pilose; anal scale triangular, rather large, pilose. Repugnatorial pore small, partly concealed by the transverse suture, which is moderately excised. Pairs of feet, 50-65, not equaling width of body, rather stout, sparsely pilose. *Male:* mandibulary stipes moderately produced beneath. First pair of feet short, scarcely thickened, strongly uncinate. Genitalia half concealed; anterior plate entirely concealed, except the end; large, flat, the ends turning outwards, rounded; posterior plate composed apparently of three pieces, strongly twisted together at base, anterior part expanded at the end, ending in an inward curving spine, middle part not expanded, end pointed, posterior blade-like, pointing inwards and projecting out on the inner side of the others, the tip rounded. Flagellum not detected. Length of body, 8-12 mm.; width, .7-1 mm.

Habitat, Pennsylvania, District of Columbia, and Indiana.

I have examined numerous specimens of this species from Bloomington, Indiana, where it seems to be common in orchards and pastures having a thick growth of grass.

The females are considerably more robust than the males.

3. JULUS MINUTUS Brandt.

Julus pusillus Say, Journ. Acad. Nat Sci. Phila., 106, 1821 (pre-occupied).
Julus minutus Brandt, Recueil, 89, 1840

Brown, a lateral row of ovate, black spots, feet pale, antennæ black and white; a dark band and three white spots, forming a △ between the eyes. Slender, finely wrinkled above, not pilose. Vertex with a very faint median sulcus; setigerous foveolæ absent. Antennæ moderate, equaling the width of body. Eyes distinct; ocelli, 8 or 9, arranged in a single, longitudinal, curved series behind the antennæ. Segments, 35–45; sides of the first segment striate; other segments moderately striate beneath, last segment rounded, pilose; anal valves not marginate, pilose; anal scale small, rounded, pilose. Repugnatorial pore placed in the posterior division, small, not touching the transverse suture, which is straight. Pairs of feet, 55-70; slender, not extending beyond the sides of body, sparsely pilose. Length of body, 9–12 mm.; width, .5–.8 mm.

Habitat, Virginia, Florida and Indiana.

I have examined a number of females of this species from Bloomington, Indiana, and also the types of *Julus lineatus* McNeill, Mss. (Pensacola, Fla.), but I cannot find any difference between them and my other specimens, which I have identified with *minutus*. Specimens not in full color have the lateral row of spots bronze red, and with a backward pointing branch, at the upper posterior side.

Young individuals differ as follows:

Length.	*Width.*	*Eyes (ocelli).*	*Segments.*	*Pairs of Legs.*
6.2 mm.	.4 mm.	5	32	46
6.3 mm.	.5 mm	5	33	48

4. JULUS STIGMATOSUS Brandt.

Julus punctatus Say, Journ. Acad. Nat. Sci. Phila., 102, 1821 (pre-occupied).
Julus stigmatosus Brandt, Recueil. 88, 1840.

Pale brown ; posterior border of segments dark ; a lateral row of brown spots , antennæ dark, feet pale. Slender, smooth, shining, not pilose. Vertex without a median sulcus setigerous foveolæ present. Antennæ subclavate, exceeding the width of body. Eyes distinct, triangular or sub rotund ; ocelli 20–40, arranged in 5–7 series. Segments, 35–45 Sides of first segment striate. Other segments moderately striate beneath , last segment smooth, obtusely rounded, pilose ; anal valves not marginate, pilose , anal scale small, rounded, pilose. Repugnatorial pore small, placed in the posterior division, not touching the suture, which is straight. Pairs of feet, 50–75, slender, extending beyond the sides of body sparsely pilose *Male:* mandibulary stipes not much produced beneath. First pair of legs short and thick, uncinate, sparsely pilose Genitalia exposed. Length of body, 8-13 mm. , width, 5– 8 mm

Habitat, Virginia and Indiana.

I have examined about a dozen specimens of this species. It varies somewhat in the shades of color, some being almost black. Only having one full grown male, I have not attempted to give a description of the genitalia.

One young specimen differs from the adult as follows :

Length.	*Width*	*Eyes (ocelli)*	*Segments.*	*Feet.*
7 mm.	.4 mm	19-5	33	39

Genus II. SPIROBOLUS Brandt.

SPIROBOLUS Brandt, Bull Soc. Imp Nat. Mos , 202, 1833

The sub-genera are defined as follows :

a Basal part of the dorsal plates without scobina. SPIROBOLUS Karsch.
aa. Basal part of the dorsal plates with scobina. RHINOCRINUS Karsch.

Subgenus Rhinocrinus.

5. SPIROBOLUS MARGINATUS (Say).

Julus marginatus Say, Journ. Acad. Nat Sci. Phila., 105, 1821.
Spirobolus marginatus Wood, Trans. Amer. Philos. Soc., 207, 1865.

Dark brown ; segments edged with brownish fuscous ; first and last segments green or brown ; feet and antennæ brownish red. Robust, not

attenuated anteriorly, the anterior four or five segments somewhat depressed, not smooth Vertex smooth, with faint reticulating lines, sparsely punctate, most numerous between and behind eyes ; median sulcus interrupted , clypeal foveolæ 8-10. Antennæ short, not reaching the posterior border of first segment. Eyes indistinct, sub-triangular ; ocelli, 30-40, arranged in 6 series Segments, 47-52. First segment with the sides sub-acute, marginate, the anterior border nearly straight, densely punctate ; second segment produced forward into a moderately large sub quadrate plate Other segments equally punctate on both divisions, striæ moderate, decurved beneath. Last segment pointed, but not extending beyond the anal valves, finely punctate ; anal valves marginate, punctate , anal scale obtusely angled, punctate. Repugnatorial pore placed on the anterior division, large, transverse suture bent. Pairs of feet, 88-100, extending beyond the sides of body *Male :* the two anterior pairs of feet more robust than the rest ; coxæ of the 3 4 pairs most produced. Ventral plate produced into a short, rounded lobe. Genitalia internal part of the anterior plate not higher than the ventral plate, external part with the tip somewhat rounded, produced backwards and outwards , posterior plate divided at the base. the outer grooved, through which runs the inner, ends of both rounded and more or less roughened. Length of body, 45-100 mm ; width, 5-10 mm.

Habitat. Eastern United States.

I have examined numerous specimens of this species from Bloomington, Indiana, and one large female from Brooksville, Indiana, collected by Mr. Amos Butler. Specimens 50 mm. long differ in color from the full grown examples, by being dark green.

Young individuals differ from adults as follows :

Length	*Width.*	*Segments*	*Pairs of Feet*	*Eyes.*
18 mm	2 mm.	42	76	18-5
16.5 mm.	2 mm.	41	65	21-5
16 mm.	2 mm	39	62	19-5
8 mm.	1 mm.	27	32	6-3

6. SPIROBOLUS PENSACOLÆ, sp nov.

Dark green above, segments margined with reddish brown ; face, anterior and posterior segment bright green ; feet and antennæ lighter than in *marginatus.* Moderately robust, attenuated before, the twelve anterior segments somewhat flattened or crassate beneath, not smooth. Vertex smooth, sparsely punctate ; punctations not more numerous

between the eyes, median sulcus interrupted; clypeal foveolæ 8. Antennæ short, not quite reaching the posterior margin of anterior segment. Eyes distinct, trapezoidal; ocelli, 45, arranged in 7 series. Segments, 49. First segment with the sides sub-acute, marginate, anterior border sinuate; second segment with the lobe less broad and more triangular than in *marginatus*. Other segments moderately rough, punctations most numerous on the posterior division; striæ decurved, strong and rib like on the posterior division of the segments. Last segment pointed, not passing the anal valves, densely punctate; anal valves marginate, rough; anal scale rounded. Repugnatorial pore large, placed on the anterior division; suture moderately bent. Pairs of feet, 92, moderately extending beyond the sides of body. Length of body, 80 mm., width, 9 mm.

Habitat, Pensacola, Florida.

I have had one female of this species for examination. It is more related to *marginatus* than any other of our North American species. From *marginatus* this species is easily separated by the distinct attenuated body, clypeal foveolæ, form of second segment, arrangement of the ocelli, and color.

7. SPIROBOLUS UNCIGERUS Wood.

Spirobolus uncigerus Wood, Proc. Acad. Nat. Sci. Phila., 15, 1864 (California).

Dark brown, edge of segments lighter, an indistinct light median line, feet chestnut. Moderately robust, a little crassate, not attenuated, only a few anterior segments flattened beneath, not smooth. Vertex moderately smooth, distinct reticulating lines, sparsely punctate, median sulcus interrupted; clypeal foveolæ 8. Antennæ short, not reaching the posterior border of anterior segment. Eyes indistinct, sub-triangular; ocelli, 32, arranged in 7 series. Segments, 49. First segment with the sides acute, marginate, anterior margin excised, rough, densely punctate; second segment moderately produced beneath, rounded in front. Other segments rough, densely punctate; numerous short lines, striæ strong, not much decurved. Last segment acutely rounded, not passing the anal valves, densely punctate; anal valves marginate, anal scale rounded. Repugnatorial pore moderately large, placed in the anterior part, sulcus extending backwards, deep, transverse suture bent. Pairs of feet, 86, equaling the width of body. *Male:* coxæ of the third pair of feet produced from beneath into a long, spatulate appendage. Ventral plate moderately produced in the middle into a sharp point. Genitalia: inner part of the anterior plate twice as high as ventral plate, inner angle somewhat

pointed, rough, external part somewhat curved, the tip a little produced, rough; posterior plate sickle-shaped, the end slender and sharp, serrated beneath at about the middle. Length of body, 45 mm.; width, 5 mm.

Habitat, Ukiah, California.

I have examined one male of this species from the above locality, which was collected by Mr. James K. Burke.

8. SPIROBOLUS HEBES, sp. nov.

Dark ochreous brown, segments not edged with a different color; a lateral row of small black spots, feet lighter Robust, not attenuated; the anterior 2–5 segments somewhat crassate, not smooth Vertex smooth, sparsely punctate, median sulcus interrupted, clypeal foveolæ 8. Antennæ short, about reaching the posterior margin of anterior segment. Eyes distinct, sub triangular, sides rounded, ocelli 29–38, arranged in 6 series. Segments 39–41 First segment acute, more so in male than female, marginate, rather smooth, second segment strongly produced beneath, triangular and rounded Other segments not smooth, sparsely punctate, also numerous impressed lines, striæ moderate, strongly decurved beneath. Last segment obtusely rounded, moderately smooth, anal valves not marginate, anal scale rounded Repugnatorial pore small, placed in the anterior division, suture angularly bent Pairs of feet, 76–79, not extending beyond the sides of body. *Male*. coxæ of the 3–6 pairs of feet produced more than the others; trochanter of the first and second pairs large, as well as the two anterior pairs of legs are stouter than the rest. Ventral plate smooth, triangular, somewhat swollen near the outer edge. Genitalia: inner part of the anterior plate twice as high as the ventral plate, end rounded, numerous short tubercles on the anterior surface, outer part finger-like, moderately wide, end rounded and not turned outwards, smooth, posterior plate thick and somewhat curved, a short blunt lobe at base on the inner side, above this a sharp and thin one the end small, thick and rounded, beneath produced i to two serrated plates. Length of body, 45–50 mm. width, 7–8 mm

Habitat, San Diego, California.

This species is described from a male and a female, collected by Miss Rosa Smith.

9. SPIROBOLUS CALIFORNICUS (Humbert & Saussure).

Spirostreptus californicus Humb. & Sauss., Revue et Mag Zool, 177, 1870 (California).

Black, segments not edged with rufous, feet and antennæ not or scarcely paler. Robust, not attenuated before, a few of the anterior segments crassate, not smooth. Vertex rough between the eyes, smooth elsewhere, a few wrinkles in front, median sulcus interrupted; clypeal foveolæ 8 Antennæ moderate, reaching the posterior border of anterior segment Eyes indistinct, sub-circular; ocelli 45, arranged in 8 series Segments, 48 Sides of first segment acute, marginate, anterior border sinuate, moderately smooth; second segment strongly produced and turned forwards, the lobe quadrate. Other segments densely punctate, and with numerous short lines; striæ moderate, concentric. Last segment rounded, smooth, anal valves not marginate, anal scale transverse. Repugnatorial pore small, placed in the anterior division, suture bent. Pairs of feet, 90, about equaling the width of body. Length of body, 75 mm.; width, 10 mm.

Habitat, St. Vincent, Lower California.

I have one broken example of this species from the above locality, collected by Mr. Charles R. Orcutt, of San Diego, Cal. The specimen before me agrees with the short description given in the journal cited above.

10. SPIROBOLUS SPINIGERUS Wood.

Spirobolus spinigerus Wood, Proc. Acad. Nat. Sci. Phila., 15, 1864 (Florida and South Carolina).

Dark greenish brown or black, segments edged with brownish red, feet and antennæ red Moderately robust; anterior segments somewhat attenuate, barely crassate, only the anterior and posterior segments punctate, rest smooth Vertex smooth, very finely and sparsely punctate, punctations not numerous between eyes, sulcus barely continuous; clypeal foveolæ 10–12 Antennæ moderate, usually reaching the middle of second segment Eyes indistinct, sub triangular; ocelli, 35–45, arranged in 6 or 7 series. Segments, 45–52. First segment with the sides sub-acute, marginate, anterior margin sinuate, smooth, finely punctate; second segment not much produced beneath. Other segments smooth, not punctate, striæ of the anterior segments weak, not much decurved, more so posteriorly. Last segment smooth, finely punctate, pointed, but not passing the anal valves; anal valves moderately smooth, marginate; anal scale rounded. Repugnatorial pore large, placed on the anterior part, suture bent. Pairs of feet, 84–98, not extending much beyond sides of body, *Male:* coxæ of the third and fourth pairs of feet produced into long appendages. Ventral plate produced into a lobe, as in *marginatus*, but longer and more slender. Genitalia: inner part of anterior plate higher than

the ventral lobe, rough, sinuate on the upper edge near the outer side, external part with the end curved sharply backwards and outwards; posterior plate divided as in *marginatus*, upper lobe or part grooved, the end rounded, a sharp, robust spine on the inner side, the lower or inner lobe thin, the end angular. Length of body, 60–80 mm.; width, 5–9 mm.

Habitat, Florida and South Carolina.

I have examined numerous specimens of this species from Pensacola, Florida.

Young examples differ from the adults as follows:

Length.	*Width.*	*Segments*	*Feet.*	*Ocelli.*
25 mm.	2.5 mm	50	80	24–6
27 mm.	3 mm.	49	81	25 6
24 mm	2.5 mm.	44	65	15-5
22 mm.	2 3 mm.	43	70	19–6

Genus III. PARAJULUS Humbert & Saussure.

PARAJULUS Humbert & Saussure, Revue et Mag Zool, 155, 1869 (*olim cras*)

Eyes triangular, elliptical or trapezoidal, ocelli numerous, not arranged in more than ten series Antennæ subfiliform, scarcely subclavate, second joint longest Mandibulary combs, 9–10 Gnathochilarium scarcely sub spatulate, stipes not separated, mentum bi-partite, almost hidden. lingual plate separated, lingual lobes denticulated Number of segments uncertain, 40–70, sides striate Last segment more or less produced into a spine, anal scale triangular or somewhat rounded Repugnatorial pore beginning on the sixth segment, placed in the posterior part. Third segment apodous Feet equaling the width of body, seventh joint longer than third; second pair of feet very strongly stunted or dwarfed *Male*: First pair of legs enlarged, six jointed, the fourth largest

To this genus have been referred our larger species of so-called *Julus*; from the latter genus it is easily separated by the number of mandibulary combs, by the second pair of legs, and the first pair of the male.

This genus is divisible into the following sub-genera:

* Male: Promentum very large, ovate, narrowing the lingual plates, first segment enlarged, sides very broad, almost sub-quadrate, first

pair of feet very large, crassate, curving inwards and crossing each other, armed with numerous tubercles on the inner side, moderately pilose. PARAJULUS I.

** Promentum and first segment same size in both sexes; first pair of feet of male small, stumpy, crassate and straight, tubercles absent, sparsely pilose. PSEUDOJULUS, subgen. nov. II.

Subgenus Parajulus.

11. PARAJULUS IMPRESSUS (Say).

Julus impressus Say, Journ. Acad. Nat. Sci. Phila., 108, 1821.

Chestnut-brown, the median line and a lateral row of spots black, also an indistinct row of large dark spots partly covered by the feet; segments above with two short light lines, and pale spots on each side of the lateral line; feet pale; line between the eyes not very dark. Moderately slender, not pilose or smooth. Vertex with a median sulcus, setigerous foveolæ present. Antennæ long and slender, equal to the width of the body, moderately pilose. Eyes distinct, triangular, the sides somewhat rounded; ocelli, 40–60, arranged in 7-10 series. Segments, 45–55. First segment with the sides striate. Other segments not deeply striate, numerous indistinct wavy striæ above. Last segment with a moderate short spine, not projecting beyond the anal valves, sparsely pilose; anal valves smooth, sparsely pilose, scarcely marginate; anal scale triangular, sparsely pilose. Repugnatorial pore moderate, oval or round, partly hidden by the transverse suture, which is sharply emarginate. Pairs of feet, 70–90, equaling width of body, rather stout, sparsely pilose. *Male:* Mandibulary stipes rather strongly produced beneath. First pair of feet large, long, not much curved, the inner surface with numerous tubercles, a few spinous ones near the base, sparsely pilose. Coxæ of the second pair of feet produced into a long, parallel appendage, the tip rounded, very sparsely pilose. Genitalia fully exposed, composed of three pieces; anterior plate moderately long, round, slightly twisted, the end scarcely clavate, turning outwards, densely pilose; middle plate large and thin, forming a tube; posterior plate sickle shaped, the end bifid, inner or under edge strongly serrated, a thin lanceolate spine springing from the base. Flagellum not detected. Length of body, 18-32 mm., width, 1.8–2 mm.

Habitat, Georgia, Illinois, Indiana, Michigan and Minnesota.

I have examined specimens of this species from Ludington, Michigan, and Chauncey, Indiana; those from the latter place are larger and darker in color.

Wood's plate of the genitalia does not show the serrations, etc., of the posterior plate, nor the true form of the middle plates.

Specimens not adult vary as follows:

Length.	*Width.*	*Segments*	*Pairs of Feet.*	*Ocelli.*
10.4 mm.	.9 mm.	48	73	30–6
9.6 mm.	.85 mm.	47	70	26–6
11.2 mm.	.92 mm.	46	75	27–6
11.8 mm.	.9 mm.	45	65	38–7
8.3 mm.	.75 mm.	40	54	22–5

12. PARAJULUS ELLIPTICUS, sp. nov.

Color almost similar to that of *J. impressus*, but darker, feet pale. Moderately robust, not smooth or pilose, shining, somewhat attenuated before. Vertex smooth, a median sulcus, setigerous foveolæ present. Antennæ not equaling width of body, densely pilose. Eyes distinct, almost elliptical, ocelli somewhat crowded, 40–48, arranged in 6–8 series. Segments, 47. First segment moderately large, sides striate. Other segments rather deeply striate, rough, with numerous short wavy striæ. Last segment produced into a moderately large, robust spine, projecting beyond the anal valves, sparsely pilose ; anal valves smooth, not marginate, sparsely pilose ; anal scale obtusely triangular, rather large. Repugnatorial pore small, not touching transverse suture, which is scarcely emarginate. Pairs of feet, 71, extending beyond sides of body, moderately stout, sparsely pilose. Length of body, 28–30 mm ; width, 2.3–2.5 mm.

Habitat, Fort Snelling, Minnesota.

I have examined two female specimens, collected by Mr. Walter D. Howe.

From *castaneus* it is distinguished by the eyes, repugnatorial pore and anal scale ; it is also more robust, and differs somewhat in color.

13. PARAJULUS CASTANEUS, sp. nov.

Color much as in *J. impressus*, but the lateral line of spots larger and confluent posteriorly, a very dark line between the eyes, feet dark. Moderately slender, rough, not pilose. Vertex very finely wrinkled, a faint median sulcus, setigerous foveolæ present. Antennæ moderate, equaling width of body. Eyes distinct, triangular, ocelli, 54,

arranged in 8 series Segments, 42–51. Sides of first segment striate. Other segments deeply striate; above numerous fine striæ, which have a number of short branches. Last segment produced into a moderate spine, which projects beyond the anal valves, not pilose; anal valves not marginate, very sparsely pilose; anal scale obtusely rounded, rather small, pilose Repugnatorial pore moderate, touching the transverse suture, which is sharply sinuate. Pairs of feet, 66, equaling width of body, rather slender, sparsely pilose. *Male:* Mandibulary stipes strongly produced beneath. First pair of feet large, uncinate, numerous tubercles on the inner surface, pilose. Coxæ of the second pair as in *J. impressus.* Genitalia about half concealed, composed of three parts; anterior plate round, the end strongly clavate, pilose; the middle plate rounded, curving up in front of anterior and then backwards between it, where it expands into an elongate, wavy plate; on the inner side it is divided into three lobes or spines, the anterior large and placed at the beginning of the expansion, the second small and placed near the end, which is somewhat serrated, a lanceolate spine springing from the base; posterior plate whip-like, curving upwards and inwards until they meet, and then outwards. Flagellum not detected. Length of body, 30 mm., width, 2 mm.

Habitat, Fort Snelling, Minn.

I have examined one male and one female, in a broken condition, collected by Mr. George Howe.

14. PARAJULUS PENNSYLVANICUS (Brandt).

Julus pennsylvanicus Brandt, Recueil, 85, 1841

Dark brown, a black median line and a lateral row of spots, feet pale. Moderately robust rough, pilose each segment except the first having two rows of setigerous foveolæ placed on the posterior division, the first row on the anterior third and the other along the posterior border. Vertex with a faint median sulcus, setigerous foveolæ present Antennæ long, equal to the width of body. Eyes distinct, triangular, ocelli more or less prominent, 40–70, arranged in 8–9 series. Segments, 55–65 First segment with four rows of setigerous foveolæ, sides striate Other segments moderately striate beneath, posterior division of each segment marked with fine striæ Last segment produced into a short spine, not projecting beyond the anal valves; not smooth, densely pilose; anal valves not marginate, rough, densely pilose; anal scale small, rounded, pilose Repugnatorial pore moderate, partly hidden by the transverse suture which is rather sharply emarginate Pairs of feet 100–112, not extending much beyond the

width of body, densely pilose. *Male:* Mandibulary stipes strongly produced beneath. First pair of legs large, uncinate, the inner surface with numerous tubercles, pilose. Ventral margin of the seventh segment not much produced. Genitalia exposed; anterior plate thick, rounded, the end somewhat clavate and scooped out, very pilose; posterior plate strongly twisted and rolled, the apex divided into three plates, the anterior lanceolate, not serrated, the others broad and thin, with the edges strongly toothed Flagellum not detected. Length of body, 20–38 mm.; width, 1 5–2 mm.

Habitat, Pennsylvania, Virginia and Indiana.

I have examined numerous specimens of this species from Bloomington, Indiana. *Julus montanus* Cope, is identical with this species.

Specimens not adult range as follows:

Length.	*Width*	*Segments.*	*Pairs of feet.*	*Ocelli.*
24 mm.	1 6 mm.	60	100	40–7
19 mm	1 mm.	47	93	35–7
12 mm.	8 mm	19	83	27–6

15. PARAJULUS CANADENSIS (Newport).

Julus canadensis Newport, Ann. & Mag. Nat Hist, 267, 1844.

Dark brown, almost black, sides with a series of yellow, conglomerated spots; feet very pale, antennæ scarcely paler. Rather slender, not smooth, shining, nor pilose. Vertex rough, a slight median sulcus, setigerous foveolæ present Antennæ short, about equaling width of body. Eyes distinct, triangular, ocelli rather flat, 43–50, arranged in 6–8 series. Segments, 56–57 First segment with sides striate Other segments moderately striate, numerous tailed-like punctations above. Last segment produced into a large, strong, round decurved spine, sparsely pilose; anal valves scarcely marginate, pilose, anal scale triangular, pilose Repugnatorial pore large, not touching the transverse suture, which is broadly but not deeply emarginate Pairs of feet, 86–93, stout, not equaling the width of body, sparsely pilose. Length of body, 18–25 mm; width, 1.3–1 5 mm

Habitat, Canada and Northeastern United States.

I have examined two females of this species from Ludington, Michigan, collected by Mr. N. B. Pierce.

Subgenus Pseudojulus, subgen. nov.

16. PARAJULUS OBTECTUS, sp. nov.

Julus impressus McNeill, Proc. U S. Nat. Mus., 1886.

Color as in *J. impressus*, but more bright and not so dark. Robust, attenuated before, not smooth, nor pilose. Vertex with a short median sulcus, setigerous foveolæ present. Antennæ long, somewhat exceeding the width of body Eyes distinct, triangular or trapezoidal in the larger specimens; ocelli numerous, 40–55, arranged in 7–9 series Segments, 50–55. Sides of first segment striate. Other segments deeply striate, upper surface as in *impressus*, but the striations not so deep Last segment produced into a rather large, stout spine, which projects beyond the anal valves; anal valves smooth, scarcely marginate, anal scale moderate, obtusely triangular. Repugnatorial pore large not touching the transverse suture, which is deeply emarginate Pairs of feet 80–95, extending beyond sides of body, moderately slender sparsely pilose *Male:* Mandibulary stipes not much produced beneath First pair of legs small, cone-like, not uncinate, sparsely pilose Coxæ of the second pair of feet not produced into peculiar appendages Margin of the seventh ventral segment not much produced Genitalia concealed. Length of body, 18–35 mm; width, 1.8–2 5 mm.

Habitat, Bloomington, Indiana, and Pensacola, Florida.

I have examined numerous females of this species, but only a few males, and I have deemed it best not to give a description of the genitalia.

This species is the type of the subgenus *Pseudojulus*.

17. PARAJULUS VARIUS, sp. nov.

Light chestnut, a median and a lateral row of spots; segments dark above, with yellow lines; a dark band between the eyes, also two large pale spots, with two smaller ones behind them; vertex or occiput with long, irregular pale spots; feet pale. Slender, not smooth or pilose. Vertex finely wrinkled, a median sulcus, setigerous foveolæ absent. Antennæ moderate, exceeding the width of body. Eyes distinct, triangular; ocelli numerous, 40–75, arranged in 7–9 series. Segments, 50–55. Sides of first segment striate Other segments not deeply striate beneath, finely wrinkled and striate above Last segment produced into a moderate, robust spine, barely passing the anal valves; anal valves not marginate; anal scale triangular, large, sparsely pilose Repugnatorial pore moderate, not touching the transverse suture, which is straight or nearly so Pairs of feet, 75–90, scarcely

extending beyond the sides of body, sparsely pilose. *Male:* Mandibulary stipes not much produced beneath; first pair of feet slightly bent inwards; genitalia concealed. Length of body, 25–30 mm.; width, 1.5–2 mm.

Habitat, San Diego, Cal. (Miss Rosa Smith); Ukiah, Cal. (Mr. James K. Burke); Rosario Mission, S. Cal. (Mr. Charles R. Orcutt).

I have examined two specimens from San Diego, three from Ukiah, and numerous specimens, mostly broken, from Rosario Mission. Those from the latter are almost black in coloration, and lack the median and lateral rows of spots, but otherwise there is no difference.

Genus IV. NANNOLENE, gen. nov.

Eyes triangular, ocelli arranged in several series. Antennæ short, subclavate, joints longer than wide, second and sixth subequal, the latter enlarged as in *Cambala.* Mandibulary combs six (5). Gnathochilarium barely spatulate, stipes separated, attenuated towards the base, mentum entire, exposed, promentum almost as in *Julomorpha,* posterior plate trapezoidal, anterior lanceolate-triangular, lingual plates separated, lingual lobes denticulated. Segments constricted in the middle, the anterior ten segments striate from the feet to the repugnatorial pore, the striæ diminishing on the other segments; at the junction of the anterior and posterior parts are round impressions, larger than the pore, extending around all, except the first 6 or 8; first segment nearly as wide as the next two. Repugnatorial pore beginning on the sixth segment, placed in the posterior part. Fourth segment apodous. Feet long and slender, seventh joint longer than the third. *Male:* First pair of legs about half as long as other, scarcely thickened, same number of joints, unarmed; sixth and seventh pairs of legs with the penultimate joint swollen and produced on the inner side.

This genus seems to be more related to *Cambala* than any other genus, but nevertheless it also approaches *Julomorpha,* especially in the construction of the gnathochilarium. It is distinguished from all the known genera by the first pair of feet of the male.

The following species is the type of the genus:

18. NANNOLENE BURKEI, sp. nov.

Light brown, a lateral row of large spots almost encircling the segments, feet and antennæ pale, a brown band between eyes. Slender, not smooth or pilose. Vertex smooth, a faint median sulcus, setigerous foveolæ absent. Antennæ equaling width of body, pilose. Eyes distinct, triangular; ocelli 26, arranged in 5 series, not quite all filled out. Segments, 50 or 51. Sides of the first segment with four striæ. Other segments moderately striate beneath, posterior part of the segments with fine striæ. Last segment rounded; anal valves not marginate, pilose; anal scale obtusely rounded, pilose. Repugnatorial pore small, placed on the anterior third of the posterior part of the segment. Pairs of feet about 87, slender, extending beyond the sides of body. *Male:* Mandibulary stipes slightly produced in the middle; ventral margin of the seventh segment not produced; genitalia concealed. Length of body, 25 mm.; width, 1 mm.

Habitat, Ukiah, California.

I have examined two young males and two adult females of this species. They were collected by Mr. James K. Burke, after whom the species is named. On account of the females being curled in a spiral shape, the number of segments and pairs of legs were counted with uncertainty.

The two young males differ as follows:

Length.	*Width.*	*Segments.*	*Pairs of Feet.*	*Ocelli.*
14 mm	8 mm.	44	71	20-4
13 mm.	7 mm	43	68	17-3

Genus V. CAMBALA Gray.

Cambala Gray, Griffith Animal King. II, p. 135 1832 (*annulata*)

Ocelli arranged in a single series behind the antennæ, and parallel with the first segment. Antennæ short, subclavate, the joints longer than wide, the second longest, the sixth stout and nearly as long. Mandibulary combs 6–7. Gnathochilarium somewhat spatulate; stipes attenuated at the base, separated by the promentum; mentum entire, rectangular, nearly concealed by the hypostoma, promentum very large, divided as in *Julomorpha*, posterior division converging more anteriorly, anterior division elongate triangular, lingual plates separated; lingual lobes denticulated. Segments with sharp, elevated ridges, first and last smooth. Repugnatorial pore very small, placed on an enlarged ridge. Fourth segment footless. Feet moderately elon-

gate, the seventh and third joints subequal. *Male:* First pair of legs six-jointed, the third as long as the fourth and fifth together, the last short, very blunt, unarmed; genitalia about half covered.

From any of our North American genera this may be separated by the dorsal carinæ, the ocelli, and the first pair of legs of the male.

The only species belonging to this genus besides the one here described, is *Cambala nodulosa* Butler, from the Island of Rodriguez.

19. CAMBALA ANNULATA (Say).

Julus annulatus Say, Journ. Acad. Nat. Sci. Phila., 103, 1821.

Cambala annulata Cope. Proc. Amer. Philos. Soc., 181. 1869.

Light yellowish brown, a lateral row of dark brown spots, carinæ brown, a dark line between eyes, feet and antennæ pale. Slender, cylindrical, not tapering, carinated, not pilose. Vertex without a median sulcus and setigerous foveolæ. Antennæ short, subclavate, about equal to width of body, densely pilose. Eyes distinct; ocelli 4–6, arranged in one line. Segments, 50–65. First segment large, sides marginate, posterior border with an indistinct row of carinæ. Other segments deeply sulcate, carinæ acute, anterior part of the segments with fine elevated lines. Last segment rounded, smooth, not pilose; anal valves scarcely marginate, smooth, pilose; anal scale moderate, rounded, pilose. Pairs of feet, 70–112, rather stout, equaling the width of body, sparsely pilose. *Male:* First pair of feet short, last joint blunt, unarmed, a little curved; second pair somewhat longer, armed. Genitalia nearly covered; anterior plate with the edge turned backward, the inner especially, around which curves the flagellum, end of plate divided into two lobes, pilose; posterior plate contorted, divided into two short, thickened lobes, the anterior short and bent at a right angle to the plate, posterior moderately long, a little falciform, pilose. Flagellum very long, curving around in front of the anterior plate. Length of body, 26–38 mm.; width, 1.5–2 mm.

Habitat, Indiana, Virginia, Kentucky, Tennessee and North Carolina.

Specimens not adult vary as follows:

Length.	*Width.*	*Segments.*	*Pairs of Feet.*
17.5 mm.	1.2 mm.	45	77
13.5 mm.	1 mm.	43	67
16 mm.	1 mm.	34	50

The following is a catalogue of the species of this family described from North America. I have used the following letters for the different zoo-geographical regions:

B.—Boreal or Canadian.
E.—Eastern Province.
En.—Eastern Province, northern part.
Es.—Eastern Province, southern part.
W.—West Indian, etc.
C.—Central Province.
P.—Pacific Province.
C. A.—Central American.

Family A. JULIDÆ Leach.

Genus I. JULUS Linnæus.

1. Julus canaliculatus Wood. En.
2. Julus cinerefrons Wood. P.
3. Julus cœruleocinctus Wood. ?
4. Julus exiguus Brandt. En.
5. Julus filicornis Saussure. C. A.
6. Julus hortensis Wood. En.
7. Julus laqueatus Wood. En.
8. Julus milesi Wood. En.
9. Julus minutus Brandt. E.
10. Julus owenii Bollman. En.
11. Julus stigmatosus Brandt. E.
12. Julus virgatus Wood. En.

Genus II. STEMMIULUS Gervais.

13. Stemmiulus compressus Karsch. N.

Genus III. SPIROSTREPTUS Brandt.

14. Spirostreptus abstemius Karsch. W ?
15. Spirostreptus ampussis Karsch. C. A.
16. Spirostreptus clavipes Koch. En.
17. Spirostreptus confragosus Karsch. W.
18. Spirostreptus flavicornis Karsch. W.
19. Spirostreptus fraternus (Sauss.). C. A.
20. Spirostreptus montezumæ (Sauss.). C. A.
21. Spirostreptus multiannulatus (McNiell). En.
22. Spirostreptus nutans Koch. En.
23. Spirostreptus otomitus (Sauss.). C. A.

24. Spirostreptus sculpturatus Karsch. W ?
25. Spirostreptus surinamensis Brandt. W.
26. Spirostreptus ventralis Porath. W.

Genus IV. SPIROBOLUS Brandt.

27. Spirobolus acutus (Humb. & Sauss.). W.
28. Spirobolus ? agilis Cope. Es.
29. Spirobolus angusticeps Wood. P.
30. Spirobolus angusticollis Karsch. C. A.
31. Spirobolus arboreus (Saussure). W.
31b. *Spirobolus arboreus gundlachi* Karsch. W.
31c. *Spirobolus arboreus krugii* Karsch. W.
32. Spirobolus atratus (Girard). E. s.
33. Spirobolus aztecus (Saussure). C. A.
34. Spirobolus beauvoisi (Gervais). W.
35. Spirobolus brevicollis Voges. C. A.
36. Spirobolus californicus (Humb. & Sauss.). P
37. Spirobolus caudatus Newport. N.
38. Spirobolus chichemecus (Saussure). C. A.
39. Spirobolus crassicornis (Humb. & Sauss.). W.
40. Spirobolus domingensis (Humb. & Sauss.). W.
41. Spirobolus duvernayi Karsch W.
42. Spirobolus excisus Karsch. W.
43. Spirobolus facatus Karsch. W.
44. Spirobolus flavocinctus Karsch. W.
45. Spirobolus fundipudeus Karsch. W.
46. Spirobolus gracilipes Karsch. W.
47. Spirobolus haïtensis (Gervais). W.
48. Spirobolus hebes Bollman. P.
49. Spirobolus heteropygus (Humb. & Sauss.). C. A.
50. Spirobolus ignobilis (Humb. & Sauss.). En.
51. Spirobolus marginatus (Say). E.
52. Spirobolus mexicanus (Saussure). C. A.
53. Spirobolus miniatipus Karsch. W.
54. Spirobolus multifrons Karsch. W.
55. Spirobolus mysticus (Saussure). C. A.
56. Spirobolus nahuus (Humb. & Sauss.). C. A.
57. Spirobolus nietanus (Saussure). C. A.
58. Spirobolus olivaceus Newport. C. A.
59. Spirobolus ornatus (Girard). Es.
60. Spirobolus parcus Karsch. W.
61. Spirobolus pensacola Bollman. Es.
62. Spirobolus spinigerus Wood. Es.
63. Spirobolus striolatus (Gervais). C. A.
64. Spirobolus tepanecus (Saussure). C. A.

65. Spirobolus tolteeus (Saussure). C. A.
66. Spirobolus totonacus (Saussure). C. A.
67. Spirobolus tzendalus (Saussure). C. A.
68. Spirobolus uncigerus Wood. P.
69. Spirobolus vulvanus Karsch. C. A.
70. Spirobolus woodi (Humb. & Sauss.). En.
71. Spirobolus zapotcus (Saussure). C. A.

Genus V. PAEROMOPUS Karsch.

72. Paeromopus lysiopetalinus Karsch. P.

Genus VI. PARAJULUS Humb. & Sauss.

73. Parajulus cæsar (Karsch). W.
74. Parajulus cæsius (Wood). Es.
75. Parajulus canadensis (Newport). En.
76 Parajulus castaneus Bollman. En.
77. Parajulus curiosus (Karsch). W
78. Parajulus diversifrons (Wood). En.
79. Parajulus ellipticus Bollman. En.
80. Parajulus furcifer (Harger). P.
81. Parajulus immaculatus (Wood). En.
82. Parajulus impressus (Say). En.
83. Parajulus obtectus Bollman. E.
84. Parajulus olmecus Humb. & Sauss C. A.
85. Parajulus oregonensis (Wood). P.
86. Parajulus pennsylvanicus (Brandt). En.
87. Parajulus pilosiscutus (Wood). En.
88. Parajulus rasilis (Karsch). N.
89 Parajulus tarascus (Humb. & Sauss) C. A. S.
90. Parajulus varius Bollman. P.

Genus VII. NANNOLENE Bollman.

91. Nannolene burkei Bollman. P.

Genus VIII. CAMBALA Gray.

92. Cambala annulata (Say). E.

Indiana University,
Entomological Laboratory,
Feb. 1, 1887.

V.—*On the Iron Meteorite which fell near Mazapil, Mexico, during the star-shower of November 27th, 1885.*

BY WILLIAM EARL HIDDEN.

Read January 17, 1887

Of meteoric irons which have been seen to fall, only eight are recorded, namely: that of Agram, Croatia, May 26, 1751; of Charlotte, Dickson Co., Tennessee, Aug. 1, 1835; of Braunau, Bohemia, July 14, 1847; of Tabarz, Saxony, Oct. 18, 1854; of Victoria-west, South Africa, in 1862; Nejed, Arabia, spring of 1865; of Nedagolla, India, Jan. 23, 1870, and of Rowton, Shropshire, England, April 20, 1876.

It has become my privilege to be able to add a *ninth* fall to this short list, and one, as its history proves, which is of more than ordinary scientific importance.

It seems probable that at last we are to know something positive of the composition of comets, which bodies have, up to this time, given us nothing tangible whereupon we could base our conclusions. Astronomers now generally believe that comets, shooting-stars, meteors, and meteorites, all have a common origin; and the history of this iron meteorite of Mazapil will help us very materially to agree with this belief.

"The only objection," states Prof. Hubert A. Newton, "that has been urged against the relationship of meteorites to the star-shower meteors, and the only objection which has apparent force, is the fact that no meteorites have been secured"—as yet —"that are known to have come from the star-showers." "But," he further states, "since star-showers are surely related to comets, it is reasonable to look for some relation of meteorites to the bodies and systems, of which the comets form a part;" and "if at any time," (Nature, Vol. 19, p. 315, 1879.) "a *real connection* can be traced between meteorites and shooting stars, we may begin to hope for a solution of this interesting but difficult problem."

On the 27th of August last, I received from my personal friend, Prof. Bonilla, of Zacatecas, Mexico, the meteorite hereinafter described. It came to me as a most generous gift, and with it came the very surprising information, that *it had been seen to fall*, at about nine P. M. of the twenty-seventh of November, 1885, during the periodical star-shower of the "Bielids."

Such was the remarkable importance of this fall, as shown by its history, and the possibility of its relation to Biela's comet; that I hesitated to announce it publicly, preferring to delay, until the full evidence could be substantiated in all its particulars. This has now been accomplished ; and I feel free to present to science what seems to be, beyond doubt, *a fragment of a comet.*

The general appearance of this meteorite gives ready credence to the account of its fall. Its freshness of surface, which shows in a beautiful manner the *flow* of the melted crust, as the mass rotated in its rapid flight through the atmosphere ; the presence of unusually large nodules of an amorphous graphite; the very slight superficial oxidation, and the general dissimilarity to other meteorites of the region ;—all point to a confirmation of the data of its fall.

When received, it weighed about 3950 grammes. Its present weight is 3864 grammes, or ten pounds, four and one quarter ounces troy. This discrepancy is included in the pieces detached for the purposes of chemical analysis and in obtaining a large surface for the development of the crystalline structure—the so-called figures of Widmanstätten.

Very naturally, the fall of this mass of iron might be viewed as merely a co-incident phenomenon with the November "Bielids" of 1885 ; but, to arrive at a thorough understanding of its true relation, let us consider the evidence of its fall and the history of Biela's comet, as set forth in the communication of Prof. José A. y Bonilla, who is Director of the Astronomical Observatory at Zacatecas, Mexico.

(Translation.) "It is with great pleasure that I send to you the Uranolite (skystone) which fell near Mazapil, during the night of the 27th of November, 1885. That you may the better appreciate the great scientific interest which this Uranolite pos-

sesses, I would state that everything points to the belief that it belongs to a fragment of the comet of Biela–Gambart, lost since 1852.

"I will first give the history of this celestial wanderer, and then my reasons, as an astronomer, for believing that it belongs to the comet of Biela.

"As Director of the Zacatecas Observatory, I am naturally attentive to all celestial phenomena; and remembering that in Nov., 1885, when our planet should pass through the node of the orbit of the disintegrated comet of Biela, there should happen the rain of fall ng-stars, which occurs periodically from the 26th to the 29th, I requested my pupils and various other people in different towns of the State of Zacatecas to note the fall of stars on those dates—especially on the evening of the 27th—and endeavor to count them, apprising me of their observations.

"I, myself, in the observatory, prepared for observations as follows:—Firstly, to locate with exactness the position of the radial point of the falling stars—determining their co-ordinates of right ascens'on and declination;—secondly, to obtain instantaneous photographs of them by means of dry-plates;—thirdly, to study the meteors by means of the spectroscope;—fourthly, to count the number of falling stars and note the hour of their maximum number in Zacatecas time;—fifthly, to fix among the constellations the paths of some of them, at least those most noteworthy.

"The sun having set at 5.20 P. M. (local time), I eagerly looked to the place in the heavens where the constellation Andromeda should be. Hardly had twilight vanished, at 5.47, when I could already distinguish the three principal stars of this group. At 6.20, I noticed near Alpha of the triangle the first falling star, and little by little the number increased. At midnight—two hours and a half after Gamma-Andromedæ had passed the meridian—the phenomenon had attained its greatest intensity, as I counted in thirty minutes two hundred and forty meteors shooting in all directions and not at all from the same point.

"With a six-inch equatorial I took the position of the *radial point*, from which *most* of the stars came, and its co-ordinates I made out as follows:

"Right ascension 1h. 54m. Declination $+ 43°$.

"I took several photographs, but in truth they did not prove satisfactory. Either from the difficulty in focussing, or because I did not expose them for the proper length of time, the negatives did not seem worthy of mention after I had examined them on the day following. After an exposure, I could not develop the negatives at once, for fear of losing my observations; and to develop them was the only test which would have given me an index as to the proper time necessary.

"With the spectroscope I was more successful. To my equatorial, of six inches aperture, I connected a direct-vision Secchi spectroscope with five prisms and cylindrical lens. The spectra which I noted of the falling stars were all identical. They presented a continuous spectrum with the characteristic lines of Sodium, Carbon, Iron, Nickel and Magnesium. I had never seen the atmospheric lines of nitrogen so marked and characteristic, even when observing the sun near the horizon. The existence of these nitrogen (azote) lines I explain by the extremely high temperature acquired by the air from the contact of the meteors. It is estimated by some that, on coming into the terrestrial atmosphere, these bodies possess a speed of from 30 to 60 kilometers per second (Wiess estimates 14.9), and that the air so violently compressed instantly acquires a temperature of 3000 to 4000 degrees.

"It was impossible for me to determine the trajectory of this maze of stars, as they were flying in all directions like firework-bombs; nevertheless, the greater number started from a radial point in the direction ε Persei and Algol.

"As to the number of stars which fell into the atmosphere from 6.20 P. M. until three in the morning—when a thick mist from the northeast prevented further observation—it was impossible to fix accurately, from the multiplicity of duties which engrossed me. However, my assistant, who was charged with this duty, pencil in hand, and marking from time to time the number counted, noted twenty-seven hundred and twenty meteors, or a little over five per minute.

"Other persons, to whom I had recommended the study of the phenomenon, living at various points in the State of Zacatecas, have probably over-estimated the number seen, since one in particular assured me he had counted nearly 6000. Most of

these amateur star-gazers saw the meteors however, but rendered me no other report.

"On the second day of December I received, to my great delight, from Eulogio Mijares, living on the Conception Ranch (thirteen kilometers to the east of Mazapil), a stone which he saw fall from the heavens, at nine o'clock on the evening of the 27th of November, 1885. The fall, simply related, he tells as follows, in his own words:

"'It was about nine in the evening, when I went to feed certain horses in the corral, when suddenly I heard a loud hissing noise—exactly as though something red-hot had been suddenly plunged into cold water,—and almost instantly there followed a somewhat loud thud. At once I saw the corral covered with a phosphorescent light, and suspended in the air small luminous sparks as though from a rocket. I had not recovered from my surprise, when I saw this luminous air disappear, and there remained on the ground only a faint phosphorescence such as when a match is rubbed. I saw a number of people from neighboring houses running towards me, and they assisted me to quiet the horses, which had become very much excited. We all asked each other what could be the matter, and we were afraid to walk in the corral for fear of being burned. When in a few moments we had recovered from our surprise, we saw the phosphorescent light disappear little by little, and when we had brought lamps to look for the cause, we found a hole in the ground and in it *a ball of light.* We retired to a distance, fearing it would explode and harm us. Looking up at the sky we saw from time to time exhalations or stars, which soon went out, but without noise. We returned after a little and found in the hole a hot stone, which we could barely handle; on the next day we saw that it looked like a piece of iron. All night it rained stars, but we saw none fall to the ground, as they were extinguished while still very high up.'

"This is the simple recital of the ranchman; and the Uranolite which fell is the one I send to you."

"From the numerous questions I have asked Sr. Mijares, I am convinced there was *no explosion* or breaking-up on falling.

"Others who saw the phosphorescence, etc., were: Luz Sifuen-

tes, Pascual Saenz, Miguel Martinez, Justo Lopez, and some whose names I have not obtained.

"Upon visiting the place of the fall,—(see map.)

FIG. 1.

Map of Mazapil and vicinity.

I was careful to examine the earth in and around the hole, and by careful washing I obtained a few small bits of iron which must have become detached from the Uranolite when it penetrated the earth. The hole was 30 centimeters deep (one foot).

"Probably the light which was noted came from the volatilization of the surface of the celestial body, due to the high temperature acquired by friction with the atmosphere and from the volatilized matter falling to the earth as an incandescent impalpable powder."

It is now proper to state the history of the meteors of Nov. 27th, 1885, which had their origin in the disintegration of Biela's comet.

As is well known, the comet of 1826 was discovered by the Austrian Captain Biela, at Johannisberg, on the 27th of Febru-

ary. Its orbit was calculated by Gambart, of Marsella, who also discovered that this comet was seen in 1772 and 1805, from the identity of its orbital data. Gambart and Clausen undertook the calculation of the elements of its orbit, and found that its complete revolution around the sun would be effected in seven years approximately. Damoiseau studied minutely the time at which it would again reach its perihelion, taking into account planetary disturbing influences. From these studies it was deduced that the comet would collide with the earth on the 29th of October, 1832, and all Europe was in concern as that period approached.

But on again examining the question, it was found that, although the comet would touch the earth's orbit on the 29th of October, the earth itself would not arrive at the same point until the 30th of November, that is to say, a month later—the distance between the two bodies being twenty millions of leagues.

Later observations, in 1832, corrected the elements of its orbit, and data were obtained as follows:

Reached perihelion in 1832 on Nov. 26th.	
Inclination of plane of its orbit,	13° 13′
Longitude of ascending node,	110°
Perihelion distance,	0.88
Motion,	direct.
Duration of revolution,	6.62 years.

In 1839 it could not be seen, owing to the unfavorable position of its orbit at the time of its perihelion, in the first days of July, and since it was computably near the sun and lost in its rays.

In 1846 it should have passed through its perihelion on Feb. 12th. From Dec. 21st, 1845, M. Encke, in Berlin, had already observed the comet of Biela, and on the 13th of January, 1846, to the great surprise of the observers, the comet appeared *separated into two portions* (having been seen the day before without alteration), and on subsequent days the parts separated more and more until, on the 12th of February, the day of its perihelion, the distance between the two fragments was already 310,000 kilometers.

In 1852, it should have passed through its perihelion on Sep-

tember 23d; and since the latter part of August it had been observed by Secchi, still separated into two portions, but much smaller and at a distance of 500,000 leagues. Since then it has never been seen: so that Biela's comet, broken in twain since 1846 to 1852, has been considered as lost.

According to calculation, it should have been seen in 1859, 1866, 1872, 1879, and 1885; but though astronomers have eagerly scanned the heavens, *it has never again appeared.*

On Nov. 27th, 1872, there occurred, over all Europe, a shower of meteors such as *never before had happened within the memory of man; and it is remarkable to note that calculation shows the orbit of Biela's comet and that of this innumerable host of falling stars to be the same.*

Before 1870, astronomers considered meteors as having a planetary origin and as forming rings around the sun, with nearly circular or elliptical orbits and with velocities analogous to that of the earth.

In 1870, Professor Schiaparelli, of Milan, surprised at the velocity of these bodies, which presupposes a parabolic orbit, suspected that they might have, like comets, an origin foreign to our system, and proposed the following theory:

Let us suppose a nebulous mass, or one formed of any kind of widely separated molecules, situated at the limit of the sphere of attraction of our sun, and that being animated with a relative motion, it begins to feel the solar influence. Its volume being very great, its points are situated at greatly varying distances. From this it results, that when such bodies commence to fall toward the sun, the unequally distant points gain unequal velocities. Notwithstanding these differences, calculation proves that, the periheliac distances of the different molecules are soon modified, and the orbits are so nearly alike that the molecules will follow each other, forming a species of chain, or current, which will take some time to pass around the sun. A mass whose diameter is equal to that of the sun, would take many centuries to complete this motion. This current represents physically and visibly the orbit of meteoric bodies, in the same way that a stream of water represents the parabolic trajectory of each molecule as a separate projectile. If, in its course, the earth should encounter such a procession of bodies, it would pass through them and many

would strike it, combining their own velocity with that of the terrestrial globe. Were the chain a long one, the earth would thus pass through it each year at the same point, encountering in each passage different bodies from those met with before. It is therefore easy to calculate the position of this current. Schiaparelli has made the calculations for the currents of August and November, and by a fortunate circumstance found that two well known comets have orbits which coincide in every particular with two chains of meteors.

This theory was fully confirmed by the falling of meteors on Nov. 27th, 1872. I have already stated that on that day the earth should pass, as in 1832, very close to Biela's comet, and that for some days all Europe was alarmed for the consequences of such an encounter.

The earth did, indeed, cross the orbit of Biela's comet, on Nov. 27th, 1872, and on the same date in 1885; but it then met with a disintegrated body, broken into *millions of fragments.* We have already spoken of the fact that, in 1846, astronomers were witnesses of the initial breaking, and that up to 1852 those twin comets still travelled side by side, and that from that time they have not been seen except in countless fragments.

Let us compare the meteoric showers of 1872 and of 1885.

On Nov. 27th, 1872, all Europe saw this magnificent spectacle. It could not be seen in America, as at the time of greatest intensity of the phenomenon the sun was above the horizon.

Let us listen to what Abbé Secchi says in a letter to the then perpetual Secretary of the Academy of Sciences of Paris (Lectures on Astronomy, Vol. 5, Flammarion): "We have had a brilliant appearance of meteors on the 27th of November. I was not notified of the phenomenon until 7.30 P. M., when it had been in full activity for an hour. We observed it thenceforward with the closest attention. From that time until 1 A. M., we counted 13,892 meteors, but a great number could not be counted. The entire sky was ablaze; it was literally a rain. The majority of the stars were small; nearly ten per cent. were of the second magnitude, nearly two per cent. of the first. There were many spherical ones. The radial point was, at 8 P. M., in that space comprehended by the constellations of Aries, the Triangle and the Fly; it passed at once to the base of the

Triangle, and finally, at midnight, had reached a point equidistant from the Triangle and the head of Medusa. The maximum was at 8.30 P. M., and the greatest number 93 per minute. After 11 P. M. the number diminished greatly, and by midnight there were intervals of quiet. Between 12.30 and 1 A. M., 87 only were counted. The velocity of these meteors was generally slow; the most striking traced curvilinear arcs; the heads were white in color and the tails red.

Magnets were not affected. *It is worthy of note, that the earth, during this phenomenon, was in the node of the orbit of Biela's comet.*

Many observers noted the same facts as the distinguished Director of the Roman Observatory; and as it would be too arduous a task to copy here the report of each of them, even in abstract, I will review only the most important. Facchini, at Mazzarino, counted 12,950 meteors, from 9h. 30m. to midnight. In Callanisetta, M. Zona counted 28,000 during the entire night; in Matare, 38,513; in Mondovi, 30,881. The Abbé Denza, at Moncaliera, counted 33,400 from 6 P. M. to midnight, and estimates the maximum at 8 o'clock; remarking that it was a very rain of fire, similar to that seen at the explosion of bombs.

This beautiful rain of stars was also observed in France. At Nice, by Feyssere and Maccario; at Bordeaux, by Lespiault and Roussaune; at Grenoble, by M. Breton; at Chambery, by M. Vallet; at Mâcon, by Lemoisy; etc., etc. The observers at Mâcon fixed the *radial point* with the following co-ordinates:

Right ascension, 2 h. Declination, 40°.

This point corresponds to the constellation of Andromeda. They add: "Among these meteors we observed a sphere, or globe, of fire, reddish in color, of from 5–6 minutes in diameter, which fell at 10 h. 50 m. from Procyon, and proceeding toward the horizon without leaving a trail, disappeared behind the roof of a house. We observed many brilliant stars, the majority being of the second magnitude. They generally described very short paths of from 5 to 6 degrees length, all leaving trains. Before they disappeared, they seemed to resolve themselves into a luminous dust. One of them showed no apparent nucleus, but looked like *a small phosphorescent cloud.*"

In England, the observations were exclusively those of Alexander Herschel. The phenomenon was not less noteworthy than in France or Italy. To give further observations would be a useless repetition.

The great display of meteors of Nov. 27th, 1885, is even more important than that just described; 1st,—Because it lasted a longer time, since it was observed over the whole world; 2nd,—Because of the greater number of meteors seen.

In "L'Astronomie," (published in Paris, by Camille Flammarion,) Nov., 1885, "Falling Stars" were noted as one of the principal observations to be made during the month (p. 439). "On the nights of the 27th, 28th and 29th of November, there will be seen a great number of luminous bodies which relate to the comet of Biela-Gambart, and which caused in 1872 the great shower of falling stars. The line enclosing the region whence they emanate is very irregular, and the centre is found not far from the double star *Gamma-Andromedæ*." From this notice, all astronomers prepared to study the phenomenon.

This prediction was fully confirmed, as was also the conjecture that these meteors belonged to the disintegrated comet of Biela.

I quote from the "Comptes rendues" of Dec. 7th, 1885, p. 1210, papers by M. Flammarion, to the Academy of Sciences, of Paris:—"Let me note the observations made by the Flammarion Scientific Societies of Marseilles, Brussels and Jaën. From these three points, so distant from each other, they agree as to the magnificence of the sight and in fixing upon 6 P. M. (Paris time), as the hour of maximum number. (This would be 11 A. M. in Zacatecas.)

"M. Bruguiere, president of the first mentioned of these societies, counted nearly 4000 meteors in ten minutes, emanating from three radial points, the most important being near Gamma-Andromedæ.

"M. Vuilmet, of Brussels, states that the spectacle was a marvellous one, that at 6 P. M. the sky was literally aflame, and with watch in hand one observer counted 160 meteors per minute in a single quarter of the heavens. M. Folaché, in Jaën, records the magnificent sight which the sky presented as "traversed in every direction by a multitude of falling stars."

M. Arcimis, in Madrid, wrote that he had counted 50 stars per minute at the maximum hour of the fall.

At Liége, M. Hebert saw among the multitude of meteors, one that, upon reaching star 41, of Aries, suddenly changed its course and left a luminous trail which lasted 12 minutes. M. Dupuy, at Nyon (Drôme), made the same observation.

At Prague, M. Zenger counted 14,000 meteors.

At Argel, M. Dupart states that the phenomenon commenced on the 26th.

At Tunis, M. Denisson fixes the maximum at 7 P. M.

At Suez, M. Borghetti mentions that the stars seemed to fall from the zenith like snow.

At Constantinople, M. Naviogordato states that the rain of stars was observed there and also at Athens, Smyrna and Jerusalem, in its full magnificence.

The French observers are all in accord as to the beauty of the display and the position of the radial point. We will refer principally to M. Lange de Ferrieres, at Rupt y Courtois in Muges; Haizeaux, at Guincourt; Riveau, at Grenouillé; Fedesche, at Aubenas; Bachelier, at Civray; Rouchet, at La Roche-sous-Briançon; Gully, at Rouen; Michel, at Mave; Bougé, at Nantes; Hillaire, at Vendeuvre; Annoy, at Montauban, etc.

In America. the phenomenon was also observed. Sr. Felipe A. Labadie, Mexican Consul at Nogales, Arizona, (Longitude 110° 47′ West of Greenwich; Latitude 31° 30′ North), states that "on the 27th he saw a fine shower of falling stars, and in twenty minutes (from 9h. 40m. to 10 P. M.), he counted 115. Without exception they came from Andromeda."

In Caracas (Venezuela), M. J. M. Zebar writes me, "there were a great many meteors seen here on the 27th, all proceeding from Andromeda. They began 6h. 38m., P. M."

In fact, the phenomenon was noted all over the world, and it would be useless to cite further observations.

I will only add what was recorded in the "Revue Mensuelle d'Astronomie populaire" (Paris, Flammarion, February, 1886): —"The rain of shooting-stars of the 27th of November, 1885."

"We may add materially to the numerous notices which we published in our last number. We do not wish, however, to be too prolix regarding these observations, which but confirm one

another; but it is of interest that the phenomenon was visible from all portions of the globe.

"From the island of Reunion, at the southeast of Africa, M. Dubuisson informs us that the meteoric shower was observed in all its grandeur from twilight to 1 A. M. The celestial fireworks were so marvellous that uneducated people believed that there would be no stars left in the sky. The maximum fall seems to have occurred at 9 P. M. (5h. 30m. Paris local time). The same observations are sent to us from the islands of Mauritius and Madagascar.

In the United States, the phenomenon was observed at Bloomington, Indiana, by Prof. Daniel Kirkwood; at Princeton, New Jersey, by Prof. C. A. Young, (who estimated the radial point at 2° to the northeast of *Gamma-Andromedæ*); and also by others."

As before stated, from what I have quoted regarding the numerous observations made in America, Turkey, Sweden, Belgium, Italy, Switzerland, Spain, Portugal, etc., and of the observers scattered throughout England, Germany, Austria and Russia, it cannot be doubted that the cosmical dust proceeding from the disintegration of Biela's comet enveloped the earth and was seen, as meteors, from its every part.

The conclusion thus derived from all these data is that the meteoric-shower of Nov. 27th, 1885, was of more importance than that of 1872.

M. W. Meyer,* of Berlin, has calculated the elements of these bodies and compared them with those of Biela's comet (see table below), and there can be no doubt of the identity of their orbits:

	Biela's Comet, 1852.	*Meteors, 1872.*	*Meteors, 1885.*
PERIHELION T -	Sep. 23.	Dec. 27.	Dec. 28.
LONG. OF NODE ☊ -	246° 19′	246° 6′	245° 55′
INCLINATION i - -	12° 33′	12° 40′	12° 35′
LONG. OF PERIHELION π	109° 36′	110° 18′	111° 53′
ECCENTRICITY - e -	0.7559	0.7518	0.7538
LOG. OF THE PERIHELION DISTANCE, LOG. q, -	9.9348	9.9376	9.9332

(N. B.—These elements are with regard to the apparent equinox of 1885.0.)

* "L'Astronomie," Feb., 1886, p. 69

Time of revolution—6 years and one-half, gives for the greater semi-axis 3.482. That of the comet was: 1806—3.567; 1826—3.560; 1832—3.537; 1846—3.520; 1852—3.527. There was therefore a constant diminution of the major axis of the ellipse, which is confirmed by the orbits of the Bielid meteors.

The small number of meteors seen to fall at Zacatecas, compared with those seen in Europe, may be easily explained. European observers agree in fixing the time of maximum fall at 6 P. M. of the 27th, Paris time. The corresponding time at Zacatecas was 11 A. M. of the same day. At this hour, Andromeda was below the horizon at Zacatecas, while at Paris it was at the zenith; so that observations at Zacatecas was made seven hours *after the maximum* as determined in Europe.

As already stated, the number of meteors counted in 9 hours was 2,720; whereas among the European observers, Abbé Denza, for example, estimate those counted by him in four hours at 39,546; on the other hand the observations are quite in accord with those of Consul Labadie, at Nogales, made at the same time, since he estimates 115 meteors in 20 minutes, and Pro. Bonilla and his assistants, 240 in 30 minutes.

Let us consider the possibility of one of these shooting-stars reaching the earth's surface. It is certain that three different velocities are possessed by a meteor before and during its fall, *i. e.:* Its velocity in its orbit; its acquired velocity when attracted by the earth, and its velocity in falling. We can easily estimate its orbital velocity, since we know the elements of its orbit. From calculations made by Alexander Herschel (Lectures on Astronomy, Vol. 5, p. 222), it is known that such bodies enter into the atmosphere of the earth with a minimum velocity of 19,000 metres per second. From the moment that terrestrial attraction affects them, they are compelled to abandon their original orbits and follow a new path (the curve made being parabolic), which is equal to the velocity of the earth through space multiplied by the square root of 2. As the mean velocity of our planet, in its orbit, is 29,640 metres per second, that of the meteor is 42,570. As these bodies have a direct motion, that is to say, the same as that possessed by the earth, their relative speed diminishes to 13,000 metres per second. But, on entering our atmosphere, these small bodies that have the temperature of

planetary space (—200° F.), compress the air strongly, and becoming heated their speed rapidly diminishes to between 500 and 1200 metres. There is therefore a great amount of momentum lost apparently; one portion has been used in compressing the air and the other has been turned into heat,—the temperature of the body increasing up to 2000–3000°. If the meteor be small, it will be entirely vaporized in the higher atmosphere; but if the mass be great the outer portion only will be volatilized, and the remainder will strike the earth's surface before being entirely burned away. As these bodies fall lower and lower into the more dense atmosphere their velocity diminishes proportionally, so that, upon striking the earth, they fall at the rate of 30–50 metres per second. We therefore perceive it to be possible for many meteors to fall upon the earth before being entirely dissipated, since it all depends upon the size of the mass.

As the greater portion of Biela's comet is now in small fragments, with here and there a larger one, as our observations have proved, it is a perfectly possible occurrence for some of these *to fall upon the earth* before being entirely dissipated.

I have stated already that in the Bielid shower of 1872, the Abbé Secchi saw many *spherical meteors*, and Lemoisy, at Mâcon, saw a sphere disappear in the horizon behind a house-top. Many observers saw, in 1885, *spherical meteors* quite close to the earth although they were not seen to strike. By all these data and observations we learn of the great importance of the Uranolite of Mazapil.

The very circumstantial story of the fall of this meteorite, coupled with the relative observations of the Bielids at Zacatecas, is interesting in the extreme, and we can scarcely disconnect the two occurrences as a mere coincidence.

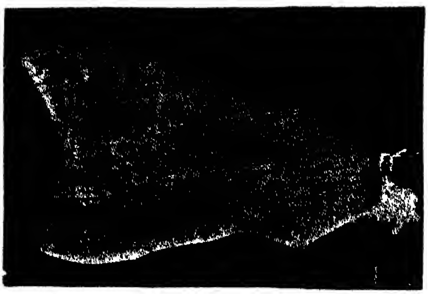
No explosion, as is usual when meteorites fall to the earth, was heard by Sr. Mijares, or his neighbors, but in this particular similar cases could be cited. Very probably the explosion, if there was one, occurred high in the atmosphere and at a great distance from Mazapil. "The aërolite which fell at Ställdalen, Sweden, at 11.50 A. M., on June 28th, 1876, was visible as a meteor over a great part of Sweden. It appeared as a large pear-shaped mass, of a blinding whiteness to some, and of a fiery-red to others. It emanated from a point in Cepheus, and became

luminous at an estimated height of 250 miles above the earth. *It is remarkable that it was not visible at the point where the meteoric mass fell*, probably on account of a small cloud of compressed matter collected in front of it."—(*Science for All.*)

The fifty-six pound meteorite, which fell, at 3 P. M. on Dec. 13th, 1795, near Wold Cottage, Thwing, Yorkshire, England (within ten yards of where a laborer was working), is remarkable for the very reason that "*no thunder, lightning, or luminous meteor accompanied the fall*; but in adjacent villages there was heard an explosion, likened by the inhabitants to the firing of guns afar off, while in two of them the sounds were so distinct,—of something singular passing through the air towards Wold Cottage,—that several people went to see if anything had happened to the house or grounds."

A careful comparison of the Agram Iron* Meteorite, with that of Mazapil, brings to light a most marked similarity of detail, though the Agram iron weighed nearly 70 German "Pfunds" (39,200 grams) or seven times more. The surface hollowings and the general irregular flat shape show the same occult cause in the origin of both of these masses of celestial iron.

The Mazapil iron in its size (3,864 grammes=10 lbs. 4¼ oz. troy), is nearly like the irons of Rowton (7¾ lbs.), Nedagolla, (11 lbs.), Charlotte (9½ lbs.), and Victoria-West (6 lbs. 6 oz.), which were *all seen to fall*.



Widmanstätten figures on Mazapil Meteoric iron.
Natural size.

* See Beiträge zur Geschichte und Kenntniss Meteorischer Stein und Metall-massen, Dr. Carl von Schreibers, Wien, 1820, Tab. VIII.

In its crystalline structure (see fig. 2, exact natural size), it closely resembles the iron of Rowton, since it exhibits lines at nearly right angles (cubic) in the Widmanstätten figures. It is also similar to the iron of Juncal, and of La Caille, and very probably, if it was cut in other directions, a more marked resemblance could be seen, especially in the twinning lamellæ and cubic structure.

The bands of iron-nickel in the Mazapil iron average one millimetre broad. In Brezina's classification it belongs among the the Holosiderites, in his "Trenton-gruppe (Omtr)" of "mittelere lamellen." It does not contain much plessite, but is mostly kamacite, and the bands present a shimmer at different angles, thus showing uniform crystallization.

Mr. O. W. Huntington has lately shown* "that the features of the Widmanstätten figures are due to the elimination of incompatable material during the process of crystallization," and that "these meteoric masses show cleavages parallel to the planes of all the three fundamental forms of the isometric or regular system, *i. e.*, the octahedron, the cube, and the dodecahedron;" and further that he "is strengthened in the opinion that the process of crystallization must have been very slow."

Where the surface-crust of the Mazapil iron has been accidentally detached, it shows, without etching, the Widmanstättian figures.

Troilite (ferrous sulphide) and Schreibersite (nickel-iron-phosphide) have been identified on the surfaces prepared for etching. Carbon (as graphite) is disseminated throughout the mass between the lamellæ, and as nodules of considerable size extruding from the surface. Eleven of them can be counted on one side, one of nearly an inch in diameter. This graphite is very hard and seemingly amorphous; scattered through it is troilite in thin plates as a mechanical mixture. Of quite exceptional occurrence is the presence in this iron of such quantities of carbon; and it is noteworthy that the spectroscope showed this element as present in the Bielid meteors of Nov. 27, 1885. The illustration (plate 1), which is three-fourths natural size,

* Proceedings of the American Academy of Arts and Sciences, May 12, 1886.

shows several of these extruding nodules of carbon.

The lines of flow of the melted crust are beautifully shown, especially when slightly magnified, and exhibit well the surface-fusion due to the rapid flight of the body through the earth's atmosphere.

That the motion of the mass in its flight was rotary, is clearly proven by the abutment of the crust-particles against the projecting surfaces and the striæ of the crust at these places, which resemble, in minute forms, limonite iron ore. The abrasion due to impact was very slight, and seemingly not more than would have happened had the mass been dropped a few hundred feet. Some places were noticed where very small pieces had been detached by the force of the impact, but in all not over 2 or 3 grams were thus lost.

The analysis, by J. B. Mackintosh, E. M., confirms the oft-noted similarity in the composition of meteoric-irons; to show this forcibly I here append a few analyses made on irons *seen to fall:*

	Mazapil. MACKINTOSH.	*Rowton.* FLIGHT.	*Charlotte.*‡ SMITH.	*Estherville.*§ SMITH.
Iron,	91.26	91.25	91.15	92.00
Nickel,	7.845	7.825	8.05	7.10
Cobalt,	0.653	0.371	0.72	0.69
Phosphorus,	0.30	....	0.06	0.112
	100.058	100.203	99.98	99.902

Lawrencite (ferrous-chloride) was noticed, by its deliquescence on the surface of the meteorite, in the deeper depressions, which deliquescence I would state, has all occurred since last August, as the surface of the mass did not show any oxidation when received.

No effort has as yet been made to analyze the graphite or to find the quantity of occluded gases in the Mazapil iron,—for the reason that such a task would only result in a repetition of the labors of Flight, Mallet, Graham and others.

‡ Am. Jour. Sci., X, 1875, pp. 349–352. Com. Rend., LXXXI, 1875, pp. 84–87.

§ Fell May 10, 1879, and consisted of metallic nodules surrounded by silicates. Am. Jour. Sci., XIX, 1880, pp. 459–463.

Concerning the evidence of the nearness of the Bielids to the earth's surface, it has long ago been shown, by Brandes and Benzenberg, that "their height varied from 40 to 90 miles while luminous," and that if they are not entirely dissipated in the earth's atmosphere they must fall to the surface. That they are all tangible bodies of greater or less size, is positively evidenced by their luminosity.

Of possible other fall of fragments of Biela's comet to the earth, on Nov. 27th, 1885, I will quote briefly a few observations which bear upon this problem :

M. de Ball, at Liege, saw "one of the meteors after its *explosion* (sic.) leave a train which lasted 15 minutes." Ciel et Terre, No. 21, Jan. 1, 1886, p. 491.

Capt. D. Wilson-Barker notes, while on the S. S. Dacia, at Suez, that "in one exceptional case the track (of a meteor) was visible for eight minutes, and for a longer time with a glass." Roy. Ast. Soc., Mon. Notices, Jan., 1886, p. 122.

Prof. N. R. Leonard states that "Prof. Cowgill, who observed at Manhattan, Kansas, saw a meteor *below the clouds* (the sky being completely clouded over) at 12h. 50m. and during the few hours following, thirteen others were seen in like manner." Sidereal Messenger, Feb., 1886, p. 58.

This latter observation and that of Prof. Leonard, at Iowa City, Iowa, are the nearest records that I have been able to find that serve to corroborate the observations at Zacatecas. Especially does the testimony of Prof. Cowgill bear upon the remark of Prof. Barnard (Sid. Mess., March, 1886, p 78), that "probably the *larger particles* of this meteoric swarm lie on the outside." That the shower was *intermittent* is evidenced by the record, viz. :

Prof. Newton, at Yale, and Prof. Young, at Princeton, agree in a diminished shower at 8 P. M. (local time), while "Prof. Leonard, at Iowa City, made the following counts: From 8h. 36m. to 8h. 51m. (local time), 100 meteors, or over 6 per minute. From 9h. 10m. to 9h. 30m., 100 meteors, or 5 per minute. From 10h. 2m. to 10h. 20m., 50 meteors, or less than 3 per minute." Sid. Mess., Feb., 1886, p. 58.

For "The story of Biela's Comet," in its entirety, I refer the reader to the beautiful account by Prof. H. A. Newton, (in the

American Journal of Science, for February and June, 1886,) and I assure you "it shall be to you as interesting as a novel," and "what is known is therein sharply separated from what is conjectured."

Not a few astronomers would have us believe that comets are the 'scavengers of space,' and have accreted their mass and obtained their motion by the simple laws of gravitation and of chemical affinity; but a careful study of meteoric masses—which are but the debris of comets—leads us to look for their birthplace within some sun or in regions where tremendous pressure must have had an existence; else the remarkable quantities of occluded gases and the otherwise plutonic character of meteorites remain inexplicable. Let us turn to the lately advanced theory of Mr. Richard A Proctor, for an explanation of great plausibility, and which seems to answer all the known conditions of comets and their attendant trains. Before stating his conclusions in abstract, I would remind the reader that he must first bring himself to believe that a body has power enough, within itself, to project a part of itself beyond the sphere of its own attraction. If you can believe this, then Mr. Proctor's theory is at once acceptable. He states*: "All the evidence tends not merely to show but to prove, that all orders of meteors, and therefore all orders of comets, came from the interior of bodies like the suns and the planets, when in the sunlike stages of their respective careers. All the evidence tends further to prove that sunlike bodies have the power of ejection which this theory of meteoric origin requires. It is to the sunlike stage of any planet's life that we are to look for the time when ejection of the kind required was possible; and our sun is the only case of a sunlike body we can inquire into. If he cannot eject solid bodies, neither could any body when it was a sun, But cannot and does not the sun eject solid bodies ??

"Those who imagine the eruption prominences to be what they seem to be—jets of glowing gas—may be disposed to answer in the negative. But in reality nothing can be much less likely than that the jet-shaped streaks of hydrogen were themselves ejected. Manifestly they indicate the tracks of denser bodies,

* Letter to the Editor of the New York Tribune, Sep. 20, 1886.

not themselves visible, because the spectroscope will not show bodies near the sun which shine with all the spectral colors (as such bodies would), but only those which shine with a few special tints (as the glowing hydrogen along the track of such bodies would shine)."

"Nor need we wonder that bodies ejected from the sun's interior are solid even from the time of their exit, when we remember how the expansion of the compressed vapors driven forcibly upward from a solar volcano (far below the visible surface) would result in a very rapid cooling, by which a portion of the vapor would necessarily condense into the solid form. In fact this is the very process which Sorby recognized as indicated by the microscopic structure of meteorites.

"It may doubtless be the case that of ejected meteoric bodies far the greater number return to the sunlike orb ejecting them. But if only one flight, consisting perhaps of thousands of small bodies, escapes from our sun in a year, of how many millions of such flights has he been the parent! His hundreds of millions of fellow suns have been doing and are doing like work; the thousands of millions of planets have done similar work in the past; each flight would be a comet, each component body a meteor, and all that is known of comets and meteors would be explained by this account of their origin."

I cannot close this already too long paper without expressing my heartfelt obligation to Professor Bonilla for the interesting data concerning this meteorite, and for the gift of the meteorite itself, and to Mr. Mackintosh also, for his kind interest in making the chemical analysis.

VI.—*Descriptions of New Species of Birds of the Families Sylviidæ, Troglodytidæ and Tyrannidæ.*

BY GEORGE N. LAWRENCE.

Read May 9, 1887.

1. Regulus satrapa aztecus.

MALE.—The upper plumage is of a dark olive-green, tinged with yellowish, and is ashy on the hind neck; the rump is lighter in color than the back, and more yellow; the sides of the neck are grayish-ash; the tail-feathers are dark brown, edged with greenish-olive; the wings are dark brown like the tail-feathers; the secondaries have a very narrow edging of yellowish; the inner margins of the quills are whitish; the ends of the greater wing-coverts are dull ashy-white, forming a band across the wing; there is a white line across the front, which extends over and behind the eyes; this is grayish in front of the eyes, and pure white behind them; the eyes are encircled with black; over the white superciliary stripe is one of black, which crosses the front and extends along the edge of the crown to the occiput; the crest is very full, and is of a bright orange-red color, bordered with pale yellow; the under plumage is of a clear olive brown, inclining to whitish on the chin and middle of the abdomen; the bill is brownish-black; the tarsi and toes are of a clear hazel-brown.

Length, 3.50 inches; wing, 2 25, tail, 1 70; culmen, 0.30; tarsus, 0.68.

Habitat, City of Mexico. Type in my collection.

Remarks.—This species is of a smaller size, with a longer and larger bill, and much darker coloration than the true *R. satrapa*. It has also the crest conspicuously larger and rather brighter; and the yellow bordering the crest is clearer in color.

I have no specimen of *R. satrapa olivaceus* with which to make a comparison; but Mr. Ridgway has kindly made it, and sent me his observations as follows: "It is remarkable for its very deep coloration, in which respects it far exceeds any specimen of *R. satrapa olivaceus* from the northwest coast (Oregon to Sitka), with which I have been able to compare it. The lower parts are dull light grayish-brown, tinged with olive and buff,

and inclining to dull whitish on the chin and middle of abdomen; on the other hand the superciliary stripe is pure white (except anteriorly), and therefore, on account of the contrast, unusually conspicuous; the upper parts are a much darker and richer olive-green than in the darkest-colored examples of *R. satrapa olivaceus* before me, the color changing to deep smoky-gray or grayish-brown on the hind neck; the olive-green edgings to secondaries, etc., are decidedly brighter or deeper than in *R. satrapa olivaceus*, and the broad pale olive-yellowish or whitish bar across the tips of the greater wing-coverts, always distinct in *olivaceus* and true *satrapa*, is almost obsolete. The head-pattern appears to be quite the same as in more northern birds, and the color of the markings not appreciably different."

Mr. Ridgway suggested as appropriate, the name of *Regulus satrapa aztecus*, which I have adopted.

2. Troglodytes brachyurus.

The upper plumage is of a warm umber-brown, the tail is more of a grayish-brown, closely crossed with narrow blackish-brown bars; the wing-coverts and outer margins of the quills are colored like the back, the tertials and outer webs of the quills have faint darker bars; the inner webs of the quills are dark brown, the lores and a very distinct superciliary stripe are white; the sides of the head are mottled with light gray and dull white, between which and the superciliary stripe is a brown line; the sides of the neck are ash-color; the entire under plumage is grayish white, washed on the sides, lower part of the abdomen and under tail-coverts with pale rufous, the latter marked with brownish bars; the upper mandible is brown, the lower whitish; the tarsi and toes are hazel-brown.

Length, 4 inches; wing, 2; tail, 1.25; bill, 0.50; tarsus, 0.70

Habitat, Yucatan. Taken at Temax, May, 1884, by Geo. F. Gaumer. Type in my collection.

Remarks.—Compared with *T. intermedius*, the colors throughout are much lighter, being grayish-white below, instead of light rufous; the bill is a little longer, but the wings and tail are much shorter; it differs also in being without the concealed white spots on the rump, which exist in *T. intermedius*.

3. Octhœca flaviventris.

Front and crown dark brown, forming a decided cap; upper plumage

greenish-olive ; tail hair-brown ; quills of a dark rich brown ; the secondaries have their outer edges partially marked with dull pale rufous ; wing-coverts dark brown, the greater ones margined with dull pale rufous ; under wing-coverts whitish, blotched with brown ; inner margins of quills very pale salmon-color ; throat grayish-ash ; breast, sides and under tail-coverts light brown ; abdomen of a clear pale yellow ; upper mandible black, the lower whitish ; tarsi and toes light hazel-brown.

Length, 5 inches ; wing, 2.63 ; tail, 2.25 ; bill, 0.38.

Habitat, South America. Precise locality unknown. Type in my collection.

Remarks.—The only species with which it seems necessary to make comparison is, *O. gratiosa*, Sclater. The wings are shorter and the tail is longer than in that species, the bill is larger and the under mandible is pale in color, instead of brown ; in their upper plumage they are somewhat alike, but *gratiosa* has the back ruddy-brown, in the other it is greenish-olive ; the under plumage of *gratiosa* has a general yellowish cast, buffy on the abdomen, whereas in the new species, the yellow is restricted to the abdomen, and is a clear pale yellow ; the tail of the new species is light brown, that of *gratiosa* blackish-brown.

VI.—*The Genera and Species of North American Carboniferous Trilobites.*

BY ANTHONY W. VOGDES.

Read, March 28th, 1887.

CONTENTS :—

I.—INTRODUCTION.

The known Carboniferous Trilobites of North America consist of several species of the genus *Proetus*, ranging from the Chemung to the Waverly series; twelve species of the genus *Phillipsia*, viz. : *P. insignis*, *P. Doris*, *P. Rockfordensis*, of the Waverly series; *Phillipsia tuberculata*, Burlington series; *P. Meramecensis*, Keokuk; *P. Stevensoni*, Chester series; *P. Howi*, and *P. Vindobonensis ?* Lower Carboniferous, and four species from the Middle and Upper Coal Measures. The genus *Griffithides* has five species, which range from the Keokuk to the Coal Measures.

Brachymetopus has only one species, appearing in the Waverly series.

The following brief diagnosis of the characters may be found of use in separating the genera :

PROETUS.

1 Glabella tumid, gibbous in front, but not overhanging its anterior border.
2 Marked by three pair of short lateral furrows.
3. Basal lobes separated from the glabella by very distinct furrows.
4 The axis of the pygidium is always raised above the margin and diminishes to a blunt extremity ; it has from 4 to 13 segments.

PHILLIPSIA.

1. Sides of glabella nearly parallel.
2. Marked by either two or three short lateral furrows.
3. Basal lobes continuous with the glabella.
4. Eyes large reniform.
5. Pygidium usually with a border.
6. Axis composed of from 12 to 18 segments

GRIFFITHIDES

1. Glabella pyriform.
2. No short lateral furrows on the glabella
3. Basal lobes distinct from the glabella.
4 Eyes small, suboval
5 Pygidium rounded, composed of from 10 to 13 segments

BRACHYMETOPUS

1. Glabella short, tumid
2. No short lateral furrows on the glabella
3. Basal lobes distinct
4. Eyes small, placed close to the glabella, reniform
5 The axis of the pygidium has from 10 to 17 segments

II.—CLASSIFICATION OF THE CARBONIFEROUS STRATA OF THE UNITED STATES.

LOWER CARBONIFEROUS.—In the United States, this series is represented in the West along the valley of the Mississippi River by a limestone deposit, but in the Eastern States these limestones are replaced by a sandstone and conglomerate, with occasional beds of limestone, like that of Maxville, Ohio.[1] The Lower Carboniferous sand beds of Pennsylvania thin away and gradually disappear before they reach the Mississippi, while the Chester and

[1] Geol. Sur. Ohio, Vol. 3, p. 821.

St. Louis series of Illinois, Iowa and Missouri, which were probably formed in a deep quiet sea, thin away to the eastward in Westmoreland County, Pennsylvania, to 40 feet, and in Somerset County to 25 feet.[1] Towards the South, in Virginia, the Lower Carboniferous limestones have a thickness of 822 feet, and even more in Tennessee. In Georgia these beds have a very limited outcrop, as mere borders of the small coal measures, except along one line of outliers from which the coal measure strata have been removed.[2] In the Arctic regions, rocks of the Carboniferous Limestone are exposed on the north coast of Grinnell Land, in Feilden and Parry Peninsulas, and as far west as Clements-Markham Inlet, rising on Mount Julia to a height of 2,000 feet, and much higher in the United States Range.[3]

WAVERLY.—The Waverly series includes the *Chouteau limestones*, *Vermicular sandstones* and shales of the Missouri Geological Survey; likewise that portion of the so-called Waverly group of Ohio which overlies the Cleveland shale and also the Goniatite limestones of Indiana. These beds vary in thickness from 100 to 200 feet, and contain beds of grit-stone, sandy and argillaceous shales, with thin layers of oölitic limestone in Illinois. In Michigan, Rominger includes with this series the *Huron shales*, in the southern part of the Peninsula, and also the *Marshall* and *Napoleon groups.*[4]

The Kinderhook group of Illinois contains many fossils which are identical with those of the Waverly,—omitting the Cleveland shales,—and they are equivalent to each other.

Fossils of this series appear as far west as Lake Valley, New Mexico, and also in Nevada and Arizona.

BURLINGTON SERIES.—This group takes its name from its typical locality, Burlington, Iowa. It lies immediately below the Keokuk limestone, and is separated into two beds, by its lithological characters and its fossils. (*a*) A lower bed of brown

[1] Geol. Penn. Rep. K_3, p. 100.
[2] Little's Catalogue of Ores, Rocks, &c., Georgia, p. 11.
[3] Geol. Soc. London, Vol. 1879, p. 560.
[4] Rominger, Geol. Sur. Michigan, Vol. 3, Chap. viii.

magnesian limestone, locally arenaceous; (*b*) a light gray or nearly white limestone, with some brown layers interstratified, and when free from chert, composed of nearly pure calcium carbonate. Chert and hornstone are abundant in both beds in seams and nodules.

The Burlington series appears as far west as Lake Valley, New Mexico, also in the States of Iowa, Illinois and Missouri. On the eastern and southern borders of the Illinois coal fields, no calcareous beds have yet been found occupying the horizon to which this series properly belongs. The Burlington group, as far as known, only contains *Phillipsia tuberculata*, Meek and Worthen.

KEOKUK SERIES.—This rock, in its full development, consists of a gray or bluish-gray compact, encrinal limestone, in beds separated by shaly partings; while bands of shale or marl of considerable thickness sometimes occur. At the base of the limestone a series of cherty beds appears, which resist denudation, and now form the river-bed above Keokuk, Iowa, producing rapids. At this point they have a total thickness of 60 feet, but further to the south they become greatly augmented and produce the body of strata known as the *Silicious series* in Tennessee.

The following trilobites appear in this series: *Griffithides Portlocki*, *Griffithides bufo*.

ST. LOUIS SERIES.—At St. Louis and Alton, these beds consist of regularly bedded gray or bluish gray limestone, sometimes massive, and again in thin beds, suitable for flagging-stones. Near the middle of the series, between Alton and the mouth of the Piasa, a bed of concretionary and brecciated limestone of about 20 feet thick appears; below this, the limestones are of a darker color. North of the Illinois River, the series thins out rapidly. In the southern portions of Illinois, the beds change their lithological character to a light oölitic limestone, with a thin-bedded cherty limestone at its base. In Indiana, the St. Louis series includes the *Spergen Hill* limestone and also an excellent building stone at Ellettsville. In Kentucky, rocks of this series appear on the railroad between Elizabethtown and Paducah; the top beds consist of an oölitic limestone, alternating with beds of

drab-colored lithographic limestone; below these beds a dark-blue fetid limestone appears. In Hardin and Grayson Counties, between Cecilia Junction and East View, the rocks of this series consist of a mass of coarse gray limestone, fine grained limestone, oölitic and arenaceous limestones and shales. Throughout its entire extent in Kentucky the series has a cavernous character and may be identified by its topography of sinkhole and semicircular valleys.

CHESTER SERIES.—These rocks were first described by Dr. Shumard in Marcy's Expl. Red River, p. 156, without naming the group; afterwards by Dr. Hall (Trans. Alb. Inst., 1856, Vol. 4), as the Kaskaskia limestone; and by the Geological Survey of Illinois (Vol. 1, p. 77), as the Chester group.

In Arkansas, in Washington County, the series consists of beds of dark-gray and bluish limestone, surmounted by massive, coarse and fine-grained quartzose sandstone. In Illinois it comprises three or more beds of limestone, with intercalated beds of sandy and argillaceous shales and sandstones, the whole attaining a thickness, in Randolph County. of at least 600 feet. At its typical locality, the rock forms the cliff bordering the American Bottom from Kaskaskia to Chester, and thence southward, having a continuous exposure of more than ten miles. The lower portion is composed of a compact arenaceous limestone, with shaly partings. Its central and upper beds include a thick bed of sandstone; towards the top there is a mass of green shale or marl 60 feet thick, overlain by a heavy bed of limestone. In Kentucky, this series appears on the Louisville, Paducah and S. W. R. R., above the St. Louis beds. These rocks consist of limestone, sandstone and shale, and constitute a bed of passage from the massive limestones of the Lower Carboniferous to the coal measures.

The members of this series occur at intervals from East View, Hardin Co., to Litchfield, Grayson Co., and beyond; and also at points between Scottsburg, Caldwell Co., and Tradewater River.

The Chester series contains *Phillipsia Stevensoni* and *Griffithides granulata.*

THE UPPER CARBONIFEROUS system contains in Pennsylvania the Mauch Chunk red shales, Pottsville conglomerate, and the Lower, Barren, and Upper Coal Measures. The Upper Coal Measures of Kansas, Nebraska, &c., contain the following carboniferous trilobites: *Phillipsia Cliftonensis*, *P. major*; in Illinois, *Griffithides Sangamonensis*, and *G. scitula*. The Middle Coal Measures of Missouri contain *Phillipsia Missouriensis*.

Among the carboniferous trilobites described and figured from the Upper Coal Measures of the West, there are two forms referred by Dr. Schiel (Rep. Expl. Sur. Miss. River to the Pacific Ocean, Vol. 2, p. 1, figs. 11 and 14), to the genus *Phillipsia*. The first, fig. 11, from Westport, is too imperfect to determine; the second, fig. 14, from Indian Creek, may be *Phillipsia major*, Shumard.

Dr. Geinitz (Carb. und Dyas in Neb., p. 1, pl. 1, fig. 1), mentions and figures a small pygidium from the Upper Coal Measures of Plattsmouth, Neb., which he refers to the genus *Phillipsia.*

III.—PROETUS.

Plate II, figs. 1 and 2

Proetus, Steininger, 1831, Mém. Soc. Geol de France, Vol. 1, p 355, pl. 21, fig. 6

Description —General form of the body oval, the trilobation very distinct through the entire length of the body. The head is less than a third of the total length, the pygidium is rather longer than the head. The cephalic shield is always surrounded by a border, consisting of an exterior raised rim and an inner groove or furrow The movable cheeks are sometimes prolonged into spines at their posterior angles The posterior margin of the head is formed by a grooved or furrowed border of the free cheeks on each side, and by the two basal lobes and the neck lobe, which are separated from the glabella by a very distinct and deep furrow. The occipital lobe is broader than the axial rings of the thorax which follow it. The glabella is usually rounded and gibbous in front, but does not overhang its anterior border, it has three pairs of short lateral furrows, although not always easily distinguished. The basal lobes of the glabella are very distinct.

The facial suture crosses the frontal border just in a line with the compound eye. above which it expands. forming a round palpebral lobe; then passing down close to the line of the axial furrow, it diverges outwards and crosses the posterior border obliquely behind the line of the orbit. The movable cheek is triangular, its surface is convex, and upon the highest

point is placed the large compound reniform eye, which is either smooth or facetted according to the state of its preservation

The segments of the thorax vary from 8 to 10. The axis is always strongly arched, and does not exceed the pleuræ in breadth ; the breadth of the axis diminishes very gradually to the posterior extremity. The pleuræ are more or less bent at the fulcral point, and have their extremities either pointed or rounded and their anterior margin facetted.

The pygidium varies in its elevation, but the axis is always raised above the margin, and diminishes to a blunt extremity, leaving a smooth border beyond. The number of lateral ribs varies from 4 to 13. The lateral ribs do not extend to the margin of the pygidium. The contour of the pygidium is often encircled with a border ; in some species the border is ornamented with points (*Phaeton Archiaci*, Barr). The surface of the test is most frequently smooth or finely granulated , in a few species it is striated, although in some it is both striated and granulated.

PROETUS MISSOURIENSIS, Shumard

Pl. III, Fig 1

Compare *Proetus auriculatus*, Hall, 1862, 15th Rep. N. Y. State Cab. Nat. Hist., p. 107

Proetus Missouriensis, Shumard, 1855, Geol. Sur. Missouri, p. 196, pl. B, figs 13 *a*, *b*

Proetus Missouriensis, Vogdes, 1887 Bibliography Palæozoic Crustacea.

Phillipsia Shumardi, Herrick, 1887, Bull. Sci. Lab. Dennison Univ., p. 58.

Dr. Shumard gives the following description of this species:

"Glabella tumid, greatest height about the centre, ovoid, obtusely rounded in front, truncated posteriorly, length a little greater than the width, widest behind, three furrows on each side, posterior pair strongly marked ; these commence at the dorsal sinus, about one third the distance from base to front, pass in a curve backwards, and bifurcate about midway between the centre and sides of the glabella ; one branch very shallow, is continued for a short distance almost transversely ; the other bends backwards nearly to the occipital sinus, and with the main branch partially encloses a large oval lobe on each side, the lobes separated by a space about half the width of the glabella ; middle pair of furrows, shallow, curving backwards in a direction nearly parallel with the posterior ones, but considerably shorter ; anterior pair feebly impressed, a little oblique ; occipital sinus a little convex towards the front, shallowest in the middle ; occipital ring wide, flattened, much lower than the plane of the glabella. Pygidium semi-circular, flattened convex, width double the length, margin broad and slightly concave ; axial lobe almost as wide as the lateral lobes, rounded at the extremity ; segments ten, separated by strongly marked furrows ; lateral lobes flattened,

with six or seven segments separated by shallow, but well marked furrows: surface thickly studded with granulæ, which are rather smaller than those of the glabella."

Locality.—Lithographic Limestone (Waverly series), at Hannibal, Louisiana, and Chouteau Springs, Missouri; also at Granville, Ohio.

In the Lower Carboniferous Group of North America we have seven species of the genus *Proetus*, viz.: *Proetus auriculatus* Hall, extending up from the Chemung into the Waverly series, and the following species from the Waverly series: *P. Missouriensis*, Shumard; *P. Loganensis*, Hall and Whitfield; *P. peroccidens*, Hall and Whitfield; *P. trinucleatus*, Herrick; *P. ? ellipticus*, Meek and Worthen; *P. Tennesseensis*, Winchell.

We have examined several cephalic shields of *Proetus Missouriensis* from Hannibal, Missouri, now in the American Museum of Natural History, New York City. The glabella of the largest specimen measures 15 mm. in width across its broadest portion, and about the same in length; the occipital ring is well defined, separated from the glabella by a prominent occipital sinus.

Another specimen, in the Columbia College collection, from Cameron, Missouri, shows the glabella and one movable cheek. The movable cheeks are sub-triangular in outline and highly convex; the eyes being located high up on the cheeks; the cheeks slope from the eyes at an angle of about 45° to half their width. At this point they are slightly depressed, then gradually slope off to the marginal border: the limit or marginal border of the head consists of a narrow raised band extending around the head. The genal angles appear to be obtusely rounded off. The facial suture crosses the frontal border slightly outside of a line drawn parallel with the outside of the eyes, above which it expands, forming a rounded palpebral lobe; then passing down, it diverges outwards and crosses the posterior border obliquely behind the line of the orbit. The fixed cheeks expand both before and behind the eyes.

This specimen, being an internal cast, exhibits two peculiar cone-like elevations instead of pores; they are in front of the eyes on the dorsal furrows of the glabella; the fixed cheeks at this point are slightly depressed into an oblong hollow, rounding off and cutting into the sides of the glabella. The upper shell of the specimen has been removed, and we have here the interior impressions of these *auxiliary impressions*, as Barrande calls them. These peculiar pores placed on each side of the glabella,

in the dorsal furrows of the glabella just in front of the eyes, have been observed by McCoy, Oldham, Salter, Barrande, Von Moller, and Woodward.

McCoy (Synopsis of the Silurian Fossils of Ireland, 1846, p. 43), thinks that these auxiliary impressions occupy just the position which the antennæ would have occupied, and that antennæ, being hollow organs, would leave a hole in the external integument if broken off.

Capt. Portlock (Rep. Geol. Londonderry, &c., 1843, p. 261), noticed them in his description of *Ampyx Sarsii* without remark.

Dr. Oldham (Jour. Geol. Soc. Dublin, 1846, Vol. 3, p. 189), in his description of *Griffithides globiceps*, says:—"In the furrows which separate the cheeks and glabella, about halfway between the front of the eye and the anterior margin, I have observed in all the tolerably preserved specimens which I have seen, a small hole or indentation"; but he does not offer an explanation of their use.

In 1847, Mr. J. W. Salter (Quart. Jour. Geol. Soc. London, Vol. 3, p. 251), in his article on the structure of *Trinucleus*, refers to the discovery by himself and Dr. Emmrich, of the facial suture in *Trinucleus ornatus*, and states that its course "is obliquely upwards from the eye-tubercle to the upper end of the glabella, where it appears to terminate in a solitary deep perforation, similar to those which surround the head." This is the first observation of these organs, that we know of, in the genus *Trinucleus*.

Later on, in 1852, Barrande (Système Silurian de la Bohême, Vol. 1, p. 230), refers to the observations of McCoy, and also to various genera on which he has observed auxiliary impressions. He remarks: "When the shell exists, as we have seen it in specimens of *Calymene Baylei*, etc., it is bent inwards, as a funnel shaped depression. We have thought that this bending inward of the shell was simply designed to afford points of attachment for the muscles of the jaws, and that they have the same origin as the similar indentations which we have indicated in the pleuræ of various species of trilobites, * * * * A fragment of *Cheirurus gibbus*, broken along the line of the dorsal groove and the length of the glabella, exposing to view one of the alæ of the hypostoma *in situ*, shows that this wing of the hypostoma fits at

its extremity to the interior of the little funnel-shaped projection formed upon the under side of the head-shield. These details are very distinct, owing to the very perfect preservation of this specimen with its shell. After this we cannot accept any other interpretation for the genus *Cheirurus* than that which we have given."

Valerian von Möller, in his article on the Trilobites of the Carboniferous formation of the Urals, in 1867, p. 44, notices these auxiliary impressions on the head of *Phillipsia Eichwaldi*, "as very distinct deep funnel-shaped openings which run a little obliquely and enter into the under side of the cephalothorax." He cites the opinion of McCoy and of Barrande, and remarks, "I quite agree with the observations of Barrande, and I feel sure the more one examines these indentations the more one feels satisfied that they are only superficial openings."

Dr. Henry Woodward, in his Monograph of the British Carboniferous Trilobites (Palæont. Soc. Lond., 1884, p. 71), gives a general review of the literature on this subject and remarks :— "These puncta may be, like the *fenestræ* in the head of *Blatta orientalis*, either rudimentary ocelli or the seat of some other nerve-sense, and may have been, as in *Blatta* and in *Serolis*, covered with a thin transparent portion of the integument, which served either as a simple eye, a tympanum, or an olfactory pore. We have referred to these *fenestræ* in the head of *Blatta* because they are placed, like those of the trilobites, on a suture of the head, and in front of the compound eye."

The interpretation of these cone-like organs observed upon *Proetus Missouriensis* seems to favor the conclusion of Dr. Woodward, that is, that they were organs of hearing.

PROETUS LOGANENSIS, Hall & Whitfield.

Proetus Loganensis, Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Par., Vol. IV, p. 264, pl. 4, fig. 33.

The pygidium of a small species differing very materially from *Proetus peroccidens* occurs at Logan Cañon. "The form is more nearly semicircular, being but very slightly paraboloid. The axial lobe is highly convex, rapidly tapering below and terminating abruptly a little within the posterior margin ; anterior end forming fully $\frac{1}{3}$ of the entire width of the shield.

Lateral lobes moderately convex, with a slightly thickened, scarcely elevated border of moderate width, on which the ribs become nearly obsolete. Axial lobe marked by 9 rounded and distinct annulations, exclusive of the terminal ones, strong in front and rapidly decreasing in size posteriorly. The ribs of the lateral lobes are 10 in number on each side, simple, highly rounded, and continuing entirely around the posterior margin of the shield, the most posterior ones being very faintly marked."

Geological position and locality.—Waverly group at Logan Cañon, Wahsatch Range, Utah.

PROETUS PEROCCIDENS, Hall & Whitfield.

Proetus peroccidens, Hall and Whitfield, 1877, U. S. Geol. Expl. 40th Par., Vol. IV, p. 262, pl. 4, figs. 28–32.

The authors give the following description of this species: "The glabella is conico cylindrical in form, once and a half as long as wide, very gently narrowing from the base forward, and rounded-truncate in front; very depressed-convex throughout, and marked by four pairs of transverse furrows, the posterior ones stronger, curving backward at their inner ends, nearly surrounding the posterior lobes, forming rounded convex tubercles, each of which is equal in width to $\frac{1}{8}$ that of the entire glabella. The other three pairs are faintly marked, and reach nearly $\frac{1}{8}$ across the glabella; the anterior one transverse and very obscure, distant from the anterior end of the glabella, equal to its width at the furrow; second and third pairs distinct, slightly curving backward at their ends. Occipital ring narrow, depressed-convex, and not strongly marked. Fixed cheeks narrow; palpebral lobe small, situated a little more than $\frac{1}{8}$ of the distance from the posterior border of the head, angular in outline. Frontal border thickened and rounded, well defined, but not distinctly separated from the glabella in front. Posterior lateral limbs not preserved, but narrow at their junction with the fixed cheeks. Suture-line cutting the frontal margin with a slight curvature at a point distant from the sides of the glabella equal to one-half its width at the anterior end, and rounding inward with a gentle curvature to the anterior side of the palpebral lobe, the cheek being very narrow at this point, thence passing along the top of the eye to the junction of the posterior lateral limb. Surface of the glabella and cheeks smooth, except a few granules near the base of the glabella.

Movable cheeks of medium size in proportion to the glabella, flattened convex from the base of the eye to the narrow, thickened, and chamfered marginal rim; occipital furrow narrow, not strongly marked, and reaching nearly to the depression within the marginal rim; posterior angles of the cheeks extending backward in the form of short angular spines.

Thoracic segments unknown.

Pygidium paraboloid in outline, highly convex, abruptly so at the sides and posteriorly. Axial lobe forming a little less than ⅓ of the entire width, and reaching nearly to the posterior margin, rounded and strongly elevated throughout ; gradually tapering posteriorly and narrowly rounded at the extremity , marked by from 15 to 17 annulations in different individuals, exclusive of the anterior articulating ring. Lateral lobes well marked, very convex, slightly flattened near the axis, but very abrupt at the sides and behind ; marked by from 14 to 16 very sharply elevated angular ribs, which occupy the entire border, extending beyond the end of the axial lobe, and reaching almost to the margin, leaving only a narrow plain space at the edge. The surface of the annulations is marked by a series of small nodes, or pustules, along their crests, arranged in four longitudinal rows on the axial rings, and an indefinite number, closely arranged, occur on those of the lateral lobes."

The species, in some of its features, resembles *Proetus macrocephalus*, Hall, of the shales of the Hamilton group of New York, especially in the markings of the pygidium, but it differs in the more elongate form and number of ribs of this part, while the glabella is proportionately narrower and the sides more nearly parallel ; the fixed cheeks and anterior border are narrower, and the movable cheeks terminate in spines, which is not the case with that one. The surface of the glabella and head is also destitute of the strong pustules which characterize that species.

Geological position and locality.—Waverly group at Ogden, Logan Cañon, Wahsatch Range, and Dry Cañon, Oquirrh Mountains, Utah.

PROETUS TENNESSEENSIS, Winchell.

Phillipsia Tennesseensis Winchell, 1869, Geol. Tennessee, p. 445.

We subjoin the original description :

"Glabella prominent, indented by a small round, depressed postero lateral lobe, and isolated by a deep occipital furrow, from a prominent occipital ring which extends, narrowing in width and curving backwards, entirely across the border, fading out toward the short, acute genal angle. Border concave, bounded by a prominent ridge, outside of which is a linear groove limited peripherally by a sharp elevated, delicate linear margin. Surface of the glabella, accessory lobe and neck-ring covered with fine unequal granulations ; a row of granules along the ridge of the border. Pygidium broadly rounded, nearly twice as long as broad, apparently depressed ; axis

with 8 or 9 rings, tapering to the posterior end, which is somewhat abruptly rounded off, one tenth of an inch from the extremity of the pygidium; lateral lobes with 8 or 9 segments, becoming obscure posteriorly. Border about one-sixteenth of an inch broad, marked on the under side by nine rigid, sharply impressed striæ. Exterior crust very finely and obscurely granulated. Length about $\frac{3}{8}$, breadth $\frac{5}{8}$ of an inch.

Comparisons.—According to Winchell, this species seems to approach nearer to *Proetus articulatus* Hall (15th Rep. N. Y. State Cab. Nat. Hist., p. 107), from the Chemung group, Licking Co., Ohio; but is destitute of the anterior and middle furrows of the glabella. It differs from *Proetus* (*Phillipsia ?*) *ellipticus*, Meek and Worthen, from the Waverly series, in the characters of the cephalic border, in the absence of glabella furrows, and in the border of the pygidium.

Geological position and locality:—Waverly series, Hickman Co., Tennessee.

PROETUS TRINUCLEATUS, Herrick.

Plate 2, Figs 7 8, 9.

Phillipsia trinucleata, Herrick, 1887, Bull Lab. Denison Univ., Vol. II, p. 64, pl 1, figs 23 and 23 *a*, *c*, *e*, *h*; pl 2, fig. 32; pl. 3, fig. 21.

The characteristic features of this species are drawn from the glabella; according to the author, "it is considerably longer than wide, and quite convex, the greater height being posterior to the middle. Anterior depressed margin rather narrow in front, expanded laterally, sides nearly straight or somewhat concave near the eyes; postero-lateral lobes very sharply defined, conical, oblique, with a second smaller pair in front of them, and a very faintly outlined second pair still farther forward; between the postero-lateral lobes a sharply defined, prominent, median elevation, almost as large as the others; cervical segment convex, high, often with a single median tubercle. The surface of the glabella is minutely ornamented and on either side in front of the eyes is an oval pit which has been thought by some to represent the insertion of the antennæ or organs of sense."

"The eyes are large and supported by a prominent palpebral lobe. A single movable cheek has been found; the margin is obliquely inclined, forming a prominent angle at its union with the face, middle of cheek depressed and marked with an impressed line; cheek produced i to a spine as long as the whole remainder of the cheek; length of cheek, .77 (the spine, .35); length of eye, .11. Pygidia are not rare and are very convex, the median lobe especially being convex from side to side, and particularly prominent posteriorly. The median lobe occupies $\frac{1}{3}$ or less the width of the pygidium proximally and tapers gradually, forming a portion of a regular truncate

cone ; on either side an impressed line marking off an accessory portion ; axial segments, 17–19 ; lateral lobes convex ; pleuræ flattened slightly above, separated by very deep sutures ; margin broad, longitudinally striate, abruptly deflexed ; ribs, 9–12.

Length of pygidium, 0.35 ; width, 0.45 ; length of axial lobe, 0.27. Another individual, length, 0.48 ; width, 0.56 ; axial lobe, width, 0 20 ; length, 0.40 inch. The pygidium is generally, if not always, ornamented by minute pustules on the summits of the segments which are borne on the top of a slightly elevated, flattened ridge forming the axis of the annuli "

Geological position and locality :—Waverly group, Flint Ridge, Licking Co., Ohio.

After a careful study of this species, and the figures of it given by Dr. Herrick, pl. 2, figs. 23 *h* and 23 *c*, we are inclined to refer this species to the genus *Proetus*.

PROETUS ELLIPTICUS, Meek and Worthen.

Plate 3, Fig. 3.

Proetus ellipticus, Meek and Worthen, 1865, Proc. Acad. Nat. Sci. Phila., p. 267.

Proetus ellipticus, Meek and Worthen, 1868, Palæont. Illinois, Vol. III, p. 460, pl. 14, fig. 8.

The following is a copy of the description of this species given by the authors :

"Rather small, entire outline narrow, elliptic ; cephalic shield semi-elliptic, about ⅓ wider than long, and slightly longer than the thorax—regularly and rather narrowly rounded in front and straight behind, with postero-lateral angles produced into small spines, which extend back to the fourth thoracic segment ; anterior and lateral borders with a narrow marginal rim, strongly deflected upwards, and separated from the cheeks and glabella by a deep furrow. Glabella more prominent than the cheeks, including the neck segment, a little more twice as long as wide, broader behind than in front, where it is regularly rounded, separated from the checks on each side by moderately well-defined furrows ; neck-segment more prominent in the middle than any part of the glabella, about twice as wide (antero-posteriorly) as the thoracic segments, and defined by a narrower but distinct neck-furrow, the continuation of which becomes wider, but rather less sharply impressed, as it extends straight across the posterior margin of the cheeks to their lateral marginal furrows ; lateral furrows of the glabella, excepting the posterior ones, nearly obsolete ; posterior lateral lobes small, subovate, and nearly isolated by a rather obscure lateral furrows just in front of each being directed obliquely backwards and inwards, so as to intersect the neck-furrow ; the other two lateral lobes, of which there seem to be indications

of two on each side, are very small and nearly obsolete ; anterior lobe composing nearly half of the glabella. Eyes lunate, not oblique, one-third as long as the glabella, but not so prominent, situated less than their own length in advance of the posterior margin of the cheeks near the glabella, and about half their length from the lateral margins of the cheeks ; reticulations very fine. Facial sutures intersecting the posterior margins of the cheeks near the middle, and extending forwards from the anterior side of each eye, at first close to the side of the glabella but soon curving outwards and obliquely forward, so as to intersect the lateral margins nearly in front of the middle of the eyes.

"Thorax about one-third wider than long, distinctly trilobate ; mesial lobe prominent, about once and-a-half as wide as the lateral lobe, consisting, apparently, of only 8 segments ; a little widest near the middle, and tapering posteriorly ; segments not arching forwards, but strongly arched upwards, rather flattened. Lateral lobes depressed, somewhat flattened near the mesial lobe, and rounding down rather distinctly to the lateral margins; segments narrow on their upper edges, flattened in the direction of the axis, and bent a little backwards below the knees, apparently rounded at the extremities.

"Pygidium sub-semicircular, but a little rounded at the anterior lateral angles ; about one-third wider than long, and as long as the glabella, exclusive of the neck-segments and anterior marginal rim ; rather more broadly rounded behind than the anterior margin of the glabella ; mesial lobe prominent, about as wide anteriorly as the lateral lobes, and tapering backward to an obtuse point within the margin, where it ends rather abruptly and is a little depressed, but not flattened ; consisting of nine or ten moderately defined segments ; lateral lobes depressed below the mesial lobe, near which they are slightly flattened, thence rounding to the margins ; each with about seven rather faintly defined segments, of which only the anterior one is marked with a longitudinal furrow, all extending to within a short distance of the margin, which seems to be slightly thickened.

"Surface apparently nearly smooth, excepting the glabella, which is covered with small, rather closely arranged granules, a row of very small granules may also be seen by the aid of a magnifier, along the posterior margin of the segments of the mesial lobe, both of the thorax and pygidium.

"Entire length, 0.78 inch." * * *

Locality and position:—Jersey County, Illinois; Kinderhook Group of the Lower Carboniferous series.

IV. PHILLIPSIA, Portlock, 1843.

Plate 2, Figs. 4, 10, 11.

Phillipsia, Portlock, 1843, Rep. Geol. Londonderry, etc., p. 305.

Description.—General form oval ; glabella with nearly parallel sides, marked by either two or three short lateral furrows ; the posterior angles

forming the basal lobes, always separated by a circular furrow from the rest of the glabella ; eyes large, reniform, surface finely facetted. Occipital furrow deep ; movable cheek separated from the glabella by the suture, which forms an acute angle with the circular border of the cheek in front of the glabella ; while the facial suture cuts obliquely across the posterior margin, just behind the eye, leaving a small pointed portion fixed to the glabella by the occipital lobe ; angles of cheeks more or less produced, margin of the head incurved, forming a striated and punctated rim. Thoracic segments nine in number, the axis distinctly marked off by the distinct dorsal furrows. Pygidium, usually with a rounded border, the axis composed of from 12 to 18 coalesced segments.

Hypostoma of *Phillipsia Derbiensis* is large, mesial lobe broad and spatulate, alæ small, smooth, and pointed.

PHILLIPSIA PERANNULATA, Shumard.

Phillipsia perannulata, Shumard, 1858, Trans, Acad. Sci. St. Louis, Vol. I, p. 296, pl. XI, fig. 10.

Pygidium deltoid, as wide as long, elevated ; border narrow, smooth, inflected behind, outer edge sinuate, inner edge obtusely subangulated, the anterior two-thirds marked with a shallow furrow ; posterior extremity narrow, very strongly arched ; axial lobe elevated, nearly as wide as one lateral lobe, tapering very gradually from front to posterior extremity, which is bluntly rounded and nearly terminal ; axial rings from 28 to 30, rounded, distinct on the dorsum becoming obsolete on the sides ; margins sinuate, surface of each ring studded with a single row of 4 or 5 granules, those of one ring alternating with those of the adjoining ones ; transverse furrows much narrower than the rings and not deeply impressed ; lateral lobes arched, somewhat flattened superiorly ; segments 8, subangulated, simple, gently arched forwards, posterior ones directed obliquely backwards, the last one being nearly parallel with the longitudinal axis ; transverse furrows deep and rather broad ; surface of rings garnished with a row of distinct granules.

Dimensions.—Length and width, 0.74 ; height, 0 28 inch.

Geological position and locality, Carboniferous, Guadalupe Mountains, New Mexico.

PHILLIPSIA CLIFTONENSIS, Shumard.

Phillipsia Cliftonensis, Shumard, 1858, Trans. Acad. Sci. St. Louis, Vol. 1, p. 227.

Phillipsia Cliftonensis, Herrick, 1887, Bull. Sci. Lab. Denison Univ., Vol. II, p. 61.

Pygidium small, semi-elliptical, gibbous, width greater than the length ; axial lobe elevated longitudinally, gently arched ; dorsum slightly depressed, width at forward extremity about equal to one lateral lobe excluding the smooth margin, gradually tapering and terminating in a blunt point

posteriorly ; rings from 13 to 14, sub-granulose, separated by distinctly impressed furrows ; lateral lobes angulated near the middle, flattened above and on the sides, well defined from the margin by a shallow but distinct furrow ; segments 7, rounded, separated by distinct linear sulci ; margin moderately wide and regularly convex.

Dimensions.—Length, .23 inch ; width, .25 : height, .11 ; height of axial lobe, .04 ; length of same, .19.

Geological position and locality.—Upper Coal Measures, Clifton Park, Kansas

PHILLIPSIA MAJOR, Shumard.

Plate 3, Fig. 14.

Phillipsia major, Shumard, 1858, Trans. Acad Sci. St. Louis, Vol. I, p. 226.

Phillipsia major, Meek, 1872, U S. Geol. Sur. Neb., p. 238, pl. 3, figs. 2, *a*, *b*, *c*.

—— Schiel, 1855, Rep. Expl. Sur. Mississippi River to Pacific Ocean, Vol. II, p. 108, pl. 1, fig. 11.

Phillipsia major, Herrick, 1887, Bull. Sci. Lab. Denison Univ., II., p. 60.

Head and thorax unknown. Pygidium large, elevated, approaching to semi elliptical, a little wider than long ; surface smooth or very finely punctate ; outlines of lateral edges sinuate, margin broad, particularly towards the posterior extremities: axial lobe very much elevated, gently tapering, forming about five sixths of the total length, not so wide as the lateral lobe, rather strongly arched longitudinally, sides with a broad, shallow groove running their whole length ; rings 23, very strongly arched from side to side, angulated in the lateral depressions, and their extremities directed obliquely backwards ; the first six or seven from the front are very flat in a longitudinal direction, and are separated from each other by fine scarcely impressed transverse lines or furrows. Posterior to these, the furrows are distinctly impressed to the extremity of the lobe, while the rings gradually become rounded on the dorsum, but on the sides they still continue flattened. Lateral lobes moderately convex, obtusely angulated in front ; segments 12, rounded, slightly sinuate, simple ; furrows rather strongly impressed, except the last two, which are nearly obsolete.

Dimensions.—Width of pygidium, $1\frac{20}{100}$ inch ; length, $1\frac{10}{100}$; length of axial lobe, .93 ; width of same at anterior extremity, .30,

Geological position and locality.—Upper Coal Measures, Clinton Co., Missouri ; Valley of the Verdigris River, 12 miles south of Lecompton on the Santa Fé road, Kansas ; also at Kansas City, Missouri, and Bellevue, Nebraska.

We have examined a smaller specimen of this species from Kansas City, now in the Columbia College collection. This

pygidium is well marked by a broad limb, which widens out posteriorly as the ribs become shorter; the axis is strongly arched, and marked by about 21 rings, the first five are indistinctly outlined, the others are distinctly indicated. The dorsal furrows are broad and deep, the sides are marked with 12 ribs, separated from each other by deep furrows.

Length, 24 mm.; breadth, 25 mm.

PHILLIPSIA MISSOURIENSIS, Shumard.

Plate 3, Figs. 1–2.

Phillipsia Missouriensis, Shumard, 1858, Trans. Acad. Sci. St. Louis, Vol. I, p. 225.

Phillipsia Missouriensis, Herrick, 1887, Bull. Sci. Lab. Denison Univ., Vol. II, p. 59.

We subjoin the original description:

"Pygidium semi-elliptical, elevated, width greater than length; surface very finely punctate, punctæ rather distant and arranged somewhat in quincunx; margin rather broad and smooth; axial lobe strongly arched transversely, gradually tapering, forming not quite four-fifths the total length; its width equal to about three-fourths the width of one lateral lobe; rings about 18, rounded on the dorsum and flattened at the extremities, transverse furrows narrow, distinctly impressed on the dorsum, becoming nearly obsolete before reaching the longitudinal furrows; lateral lobes rather strongly arched transversely, anterior margin angulated, apex of the angle elevated and situated nearest the axial lobe; segments 11, rounded, curving slightly downwards, not furrowed; furrows between the segments rather deeply impressed, except the two posterior ones, which are quite shallow.

Dimensions.—Length of pygidium, .68 inch; greatest width, .76; length of axial lobe, .56; greatest width of same, .23."

Geological position and locality.—Middle Coal Measures, at Lexington, Missouri.

PHILLIPSIA MERAMECENSIS. Shumard.

Plate 3, Fig. 15.

Phillipsia Meramecensis, Shumard, 1855, Geol. Missouri, p. 199, pl. B, fig. 9.

Phillipsia Meramecensis, Herrick, 1887, Bull. Sci. Lab. Denison Univ., Vol. II, p. 59.

Phillipsia Howi, Billings, 1863; Can. Nat., Vol. VIII, p. 209, fig.

Phillipsia Vindobonensis, Hartt, 1868; Dawson's Acad. Geol., p. 213.

Dr. Shumard gives the following description of his species : "Pygidium semi-elliptical, rather wider than long, very convex ; border moderately narrow ; axial lobe not quite as wide as the lateral lobes and considerably elevated above them ; anterior extremity arched ; posterior extremity obtusely rounded ; rings 15, convex on the dorsum, flattened on the sides ; transverse furrows rather deeply impressed on the dorsum, but shallow and narrow on the flattened sides ; lateral lobes strongly arched downwards ; ribs about 12, distinct, except the two or three last, which are obscure ; the first four from the thoracic margin marked with a shallow but distinct furrow, which is situated very near the posterior edge ; furrows between the ribs rather deeply impressed ; surface very finely granulated."

Dimensions.—6 lines ; greatest width, 6¼ lines.

Geological position and locality.—Archimedes limestone (Chester series), Meramec River, at Fenton, St. Louis Co., Missouri

Dr. Shumard, in his journal of observations along the routes travelled by the expeditions between Indianola, Texas, and the valley of the Mimbres, New Mexico, mentions this species as occurring in the mountains near the Ojo de la Soledad in the Carboniferous crystalline limestones. An undescribed *Phillipsia* is also mentioned by this author as occurring in the Guadalupe Mountains. (A Partial Report on the Geology of Western Texas, consisting of a General Geological Report and a Journal of Geological Observations along the routes traveled by the expeditions between Indianola, Texas, and the valley of the Mimbres, etc.; G. G. Shumard, Austin, 1886, pp. 95 and 113.

PHILLIPSIA INSIGNIS, Winchell.

Phillipsia insignis, Winchell, 1863, Proc. Acad. Nat. Sci., Vol. VII, 2d series, p. 24.

Phillipsia insignis, Billings, 1863, Can. Nat., Vol. VIII, p. 209.

Phillipsia insignis, Herrick, 1887, Bull. Sci. Lab. Denison Univ., II, p. 63.

We subjoin the original description :

"Head paraboloid ; border wide, broadly and deeply furrowed, with the margin reflected upward, and the lateral angles continued posteriorly in acuminate prolongations, reaching twice the length of the glabella from the anterior end ; the margin and reflected portion of the test marked by fine longitudinal striæ. Glabella elongate-paraboloid, tuberculated. In the middle of the posterior border of the glabella is a pair of tubercles, and in front of these a second and third pair, the last resting on the middle of the glabella—the whole so arranged as to form two longitudinal rows ; opposite

the first pair are two small complementary lobes, with four pustules on the summit of each; opposite the second pair, on each side a transversely elongated tubercle with a trifid crest; opposite the first pair a similar tubercle with a bifid crest; the ornaments on the posterior half of the glabella being consequently arranged in three transverse series, in the posterior of which are ten elevations, in the middle eight, and in the anterior six: the anterior half of the glabella is covered by pustules somewhat promiscuously arranged, and varying in different specimens. Eyes large, globoid, slightly excavated by the palpebral lobe of the fixed cheek, situated opposite the posterior third of the glabella. Occipital ring broad, with its posterior margin elevated nearly as high as the posterior extremity of the glabella, and ornamented with a row of small, raised points turned backwards.

"The pygidium very convex, semi-elliptic, the axis very prominent and forming about one-third the width at the anterior margin; consisting of 12 or 14 rings each bearing six small tubercles, the whole of which are arranged in six longitudinal rows; the tubercles often worn down on the exterior of the test, but always well defined in the cast; lateral lobes bent rather abruptly downwards, having 10 ribs, which become indistinct and disappear towards the margin, and are entirely wanting over the narrow space behind the axis; the anterior ribs showing a faint median groove towards their vanishing extremities, and a few of the posterior ones bearing feeble tuberculations towards their axial extremities"

Geological position and locality, from the base of the Burlington limestone, Burlington, Iowa.

PHILLIPSIA STEVENSONI, Meek.

Plate 3, Fig 6.

Phillipsia Stevensoni, Meek, 1870, 3d Ann. Rept. Board of Regents of West Virginia University, p 73.

This species was founded upon the glabella and pygidium, which Mr. F. B. Meek compares with *Griffithides Portlockii*, Meek and Worthen The author remarks that the pygidium "is proportionately longer, more convex, and more narrowly rounded behind," than that of *Griffithides Portlockii*; its length and breadth being very nearly or quite equal, and its height half the breadth. Its lateral lobes also slope more abruptly to the margins, which are not flattened, but very slightly thickened, obscurely striated, and abruptly sloping. It likewise shows no traces of either the furrows or granules seen on the anterior segments of the lateral lobes of *Griffithides Portlockii*, the surface of these lobes being entirely smooth, excepting minute pitting or punctures. Its prominent mesial lobe is flattened or slightly furrowed on each side, and shows fourteen segments, ornamented each by a row of small granules; while each lateral lobe has ten less strongly defined, and more depressed segments, separated merely by slight linear furrows."

"The fragment of a glabella found associated with the pygidium above

described, shows it to be rather depressed, oval-oblong, widest between the eyes, with a comparatively large sub-trigonal posterior lateral lobe on each side, extending forward to about the middle of the inner margin of each of the small palpebral lobes; and just before each of these larger lateral lobes there is another faintly defined, very small, oblique one, not extending quite so far forward as the palpebral lobes. The neck segment is comparatively wide antero-posteriorly, arched upwards nearly or quite as high as the central part of the glabella, and like the latter, ornamented with small granules.

Length of pygidium, 0.32 inch; breadth, 0.33 inch; height, 0.16 inch."

Locality and geological position.—Monongalia Co., W. Va. Chester series, Lower Carboniferous.

We have examined several specimens of this species from Monongalia Co., West Virginia, now in the possession of Prof. J. J. Stevenson, of New York city. The largest pygidium in this collection is about the same size as that described above. The axis has 14 rings, and the side lobes 10 rather flat ribs, gradually decreasing in size, and ending abruptly on the inner margin of the border, which encircles the outer portion of the pygidium.

PHILLIPSIA VINDOBONENSIS, Hartt

Phillipsia Vindobonensis. Hartt. 1868, Dawson's Acadian Geology, p. 313 (3d edition)

Phillipsia Vindobonensis, Herrick, 1887. Bull Sci Lab. Denison Univ, Vol II; p 63

The description of the species was drawn by Prof. Hartt from an imperfect pygidium: we give the original:—

"Pygidium semi-elliptical, very convex; one or two segments appear to be wanting from the anterior margin; but the width of the pygidium in that part must have been greater than its length Ten or eleven articulations are visible on the side lobes and twelve on the axis, which is very prominent and moderately tapering. The axial rings are depressed, convex, becoming smaller, more crowded, and more indistinct toward the apex. Ribs on side lobes depressed, convex, decreasing in length, breadth, and distinctness from before backward, while at the same time they become more and more inclined backward. The six anterior ribs preserved show a distinctly marked groove, originating on the posterior margin at about one-third the length of the ribs from the axis, and running obliquely, increasing in depth to the end of the rib. Smooth border, none, or extremely narrow at anterior angles, but becoming three fifths the width of the axis near the posterior part of the pygidium, which is not visible in the only specimen I have examined."

Geological position and locality.—Lower Carboniferous, Windsor, Nova Scotia. (Chester Group ?)

PHILLIPSIA DORIS, Hall.

Proetus Doris, Hall, Contributions to Palæontology, 1858–59, p. 57.

Proetus Doris, Hall, 1860, 13th Rep. N. Y. State Cab. Nat. Hist., p. 112.

Phillipsia Doris, Winchell, 1865, Proc. Acad. Nat. Sci. Phila., Vol. IX, p. 133.

Phillipsia Doris, Herrick, 1887, Bull. Sci. Lab. Denison Univ., II, p. 62.

We subjoin the original description of this species drawn by Prof. James Hall from the pygidium :

"Caudal shield semi-elliptical, convex ; the axis gibbous, rounded and very prominent in old specimens, obtuse posteriorly. The plane border of the pygidium is about half as wide as the lateral lobe, and defined by a shallow depression on the inner side, marked by about 8 ribs, while the axis is marked by 13 or 14 in full grown specimens. Surface granulous."

Geological formation and locality.—Goniatite limestone at Rockford, Indiana.

Prof. Alexander Winchell, in the Proceedings of the Acad. Nat. Sci. Philadelphia, for 1865, p. 133, remarks:

"This species was established by Hall on some pygidia occurring in the Goniatite limestone at Rockford, Indiana. I am in possession of several pygidia from this locality which agree with his description, though in the absence of measurements, it may be that his specimens are much larger. Associated with these are numerous fragments of bucklers, which prove that the trilobite is a *Phillipsia.* The head is furnished with a border sloping downwards, and separated from the cheeks by a deep but narrow groove; the middle of the border is marked by a groove which reaches from a point opposite one eye, to the corresponding point on the other side of the head ; in some specimens the latter groove reaches backward to the posterior borders of the buckler ; the cheeks are raised abruptly above the border, and terminated by spinous points which are ornamented with raised longitudinal striæ, and extend backwards a distance equal to one-third the whole length of the cephalic shield. The principal lobe of the glabella is in the form of a prolate semi-ellipsoid, is almost destitute of furrows, and is supported on each side by a large complementary lobe. The surface is obscurely granulose. The pygidium is in form of a semi-ellipse, with the longer diameter transverse ; it is convex, with a gibbous axis, obtuse posteriorly, and articulated to the extremity. The lateral lobes are a little

narrower than the axis, and their terminal points join the extremity of the axis. The pygidium is bordered by a plain belt curved downward around the margin, and barely marked by a continuation of the articulations—except the two which bound it anteriorly.

"Number of segments in the axis, 11; in the side lobe, 7; surface the same as in the buckler.

"Width of pygidium, .35 inch; length, .21; width of axis at anterior end, .12; width of border, .04; length of buckler of another specimen, 31."

Geological position and locality.—Goniatite limestone (Waverly series), Rockford, Indiana.

PHILLIPSIA ROCKFORDENSIS, Winchell.

Phillipsia Rockfordensis, Winchell, 1865, Proc. Acad. Nat. Sci. Phila., Vol. IX, 2d series, p. 133.

Phillipsia Rockfordensis, Herrick, 1887, Bull. Sci. Lab. Denison Univ., II, p. 62.

Prof. Winchell gives the following description of this species:

"Cephalic shield surrounded by a narrow, convex border, which is bounded internally by a narrow but deep groove, and terminates posteriorly in conically tapering genal points. The principal lobe of the glabella is relatively very large, convex, highest in the middle, widened anteriorly, circularly rounded in front, and gently curved on the sides; no glabella-furrows are present. The complementary lobes are large, oval, and project laterally further than the main lobe. The surface of the test of the glabella is finely but sharply granulated; that of the border is finely striated. Size about the same as that of *Phillipsia Doris*."

Geological position and locality.—Goniatite limestone (Waverly series), Rockford, Indiana.

PHILLIPSIA HOWI, Billings.

Phillipsia Howi, Billings, 1863, Can. Nat., Vol. VIII, p. 209, fig.

Phillipsia Howi, Hartt, Acadian Geol. (Dawson), p. 313, fig. 133.

Phillipsia Howi, Herrick, 1887, Bull. Sci. Lab. Denison Univ., II, p. 63.

The pygidium of this species is thus described by Mr. Billings:—

"Pygidium semi-elliptical, strongly convex, width at the anterior margin a little less than the length; 17 or 18 articulations in the axis; side-lobes with 10 or 12 ribs and a smooth border. The axis is very prominent, about one-third the width, gradually and uniformly tapering and terminating ab-

ruptly at five-sixths of the whole length in an obtusely rounded apex. The ribs on the axis are depressed convex, becoming smaller and more crowded toward the apex, each with 8 or 9 tubercles, which are confined to the middle third of the width of the axis, and are situated near the posterior margin of the ribs. The side lobes have 10 or 12 depressed convex ribs, the last three indistinct, the first three or four with a very obscure fine groove near the posterior edge, in the outer third of the length. The smooth border is about one-fourth the width of the side-lobes at the anterior angles, but a little wider behind ; all the space behind the apex of the axis is smooth. Each rib has nine or ten small tubercles near its posterior margin. On the posterior third of the pygidium there is an obscure shallow groove along the inner edge of the smooth border."

Length of the specimen, $12\frac{1}{2}$ mm. ; width at the anterior margin, about 12 mm.

Geological position and locality.—Lower Carboniferous, Kennetook, Nova Scotia.

There are two forms of the genus *Phillipsia* described by Canadian palæontologists, from the Windsor Limestone of Nova Scotia, which appear to be identical with *Phillipsia Meramecensis*, Shumard. The first, *Phillipsia Howi*, Billings, was described from a pygidium with 17 or 18 axial rings and 12 side ribs in the text, but figured with 16 axial rings and 12 side ribs. Can. Nat., Vol. VIII, p. 209.

A comparison of the second species from the Windsor limestone (*Phillipsia Vindobonensis*, Hartt,) shows no essential points of difference, except with regard to the number of axial rings in the second which are given as 12 from an imperfect specimen, with two or more of the anterior segments wanting.

PHILLIPSIA TUBERCULATA, Meek and Worthen.

Phillipsia tuberculata, Meek and Worthen, 1870, Proc Ac. Nat. Sci. Phila., Vol. XX, p. 52.

Attaining a large size. Head and thorax unknown. Pygidium semi-elliptic, the length being nearly three-quarters the breadth, very convex ; posterior margin obtusely rounded ; lateral margin diverging rapidly for ward, with convex outlines. Axial lobe well defined, obtuse, and rather prominent behind and gradually widening forward, with nearly straight sides ; rather distinctly more elevated than the lateral lobes, which it nearly equals in breadth at the anterior end, as seen in a direct view from above, but one-quarter narrower than the latter, measuring over the curve of each; showing 16 or 17 straight, well defined segments, each of which is provided with six small tubercles, arranged so as to form six rows. Lateral lobes

with about 14 segments each, the very short posterior ones being nearly in line with the axial lobe, while the others grow gradually more transverse anteriorly, so as to show only a moderate obliquity towards the front; all extending down so as to leave only a very narrow, undefined, smooth marginal space, and each ornamented by from 2 or 3 to about 12 tubercles, the number increasing regularly, with the length of the segments, towards the anterior. Surface between the segments and tubercles smooth. Length of pygidium, 0.95 inch; breadth, 1.45 inch; convexity, 0.40 inch. * * * "

Locality and position.—Kinderhook, Pike Co, Ill. Burlington division of the Lower Carboniferous.

GRIFFITHIDES, Portlock, 1843.

Plate III, Figs. 3, 5, 6 & 12.

Griffithides, Portlock, 1843, Geol. Rep. Londonderry, p 310.

Description.—Outline oblong-oval, glabella pyriform, gibbous in front, destitute of lateral furrows; basal lobes inflated. Occipital lobe broad, eyes small, lunate, smooth; facial suture marking divisions of the movable cheek clearly defined, outline broadly triangular, outer posterior angles sometimes produced into a cheek-spine. Thorax with 9 segments. Pygidium rounded, composed of about 13 coalesced axial rings Hypostome: the anterior border is strongly arched, the central body is tumid; the two alæ form blunt angles, giving breadth to the attached anterior border; the sides curve inward almost to the lower end, where there is a slight expansion; the lower free extremity is only half as wide as the upper. The border is raised and the angles truncated, the inner portion of the lower extremity is slightly raised (*G. globiceps*).

GRIFFITHIDES PORTLOCKII, Meek and Worthen.

Plate III, Fig. 9.

Phillipsia (Griffithides) Portlockii, Meek and Worthen, 1865; Proc. Acad. Nat. Sci. Phila., p. 268.

Phillipsia (Griffithides) Portlockii, Meek and Worthen, 1873; Geol. and Palæont. Illinois, Vol. V, p. 525, pl. 19, fig. 6.

Griffithides Portlockii, Vogdes, 1886: Bibliography Palæozoic Crustacea.

The authors give the following description of this species in their final report:

" Entire outline subovate. Cephalic shield sub-semicircular, nearly twice as wide as long, moderately convex, rounded in front and straight behind, with posterior lateral angles terminating in short, pointed spine-like appendages extending back to the third thoracic segment. Glabella ovate, tumid, contracted and depressed behind, widest and most convex or ventricose anteriorly, where it is about one-third narrower than its length from the neck-segment to its rounded front, which is not margined by a projecting rim; very distinct from the cheeks in consequence of its greater convexity; pos-

terior lateral lobes small, much depressed, and isolated by the oblique lateral furrows in the front being so directed as to intersect the neck-furrow ; immediately in front of these there are on each side faint traces of another small, very obscurely defined, lateral lobe ; anterior lobes ovate, ventricose, and comprising more than nine-tenths of the whole ; neck-furrow deep and and broad ; its continuation across the posterior side of the cheeks distinct, straight, and terminating at the lateral furrows of the cheeks ; neck-segment prominent, twice the size of the thoracic segments, and equaling the greatest transverse diameter of the glabella in front, but more depressed.

"Eyes in the form of somewhat oval, ventricose tubercles, considerably lower than the glabella, from which they are separated by rather wide, distinct depressions, placed about half their length in advance of the posterior margin of the cheeks, and without visible facets ; palpebral lobes depressed, not covering the eyes, but merely connecting with their inner sides, so as to leave the visual area forming an almost isolated tubercle. Cheeks sloping from the eyes into a broad, deep marginal sulcus, which is not continued around the front of the glabella, but extends back a little upon the lateral spine ; outside of this there is a thick, distinctly striated marginal rim, which becomes very nearly obsolete around the front of the glabella. Facial sutures cutting the anterior margin nearly on a line with the eyes, but curving so as to leave a small semi-circular wing on each anterior lateral margin of the glabella ; behind they intersect the posterior margin of the cheeks about midway between the lateral angles and the neck-segment, but nearer the latter. Thorax nearly as long as the glabella, exclusive of the neck-segment, distinctly trilobate ; axial lobe slightly wider than the lateral lobes, rounded a d rather prominent ; its segments narrow and straight, or not arched forward. Lateral lobes more depressed, somewhat flattened on the inner side, rounding down to the lateral margins ; segments duplicated by a nearly mesial furrow extending from their inner ends out to or a little beyond the undefined knee, beyond which they are obliquely flattened for folding together, and rounded at their extremities.

"Pygidium a little more than one-fourth wider than long, rather distinctly convex, rounded behind, and more or less straight in front, with anterior lateral angles obliquely truncated and a little rounded. Mesial lobe very prominent and well defined, rounded above, and a little flattened or furrowed on the sides ; as wide anteriorly as the lateral lobes, tapering and declining somewhat posteriorly to an abrupt, obtuse, prominent termination; about half its own greatest anterior breadth within the flattened margin ; segments fourteen or fifteen, distinctly defined, smaller than those of the thorax. Lateral lobes depressed below the mesial lobe, somewhat flattened on the inner side, and sloping to the rather narrow and more flattened border ; segments ten, somewhat oblique, well-defined for three-fourths of the distance out, and thence less distinctly so, to within a short distance of the margin ; a few of the anterior ones with an obscure longitudinal furrow. Surface granular. the granules being largest on the posterior portions of the glabella, palpebral lobes and neck-segment. On the segments of the axial

lobe, both of the thorax and pygidium, as well as those on the lateral lobes, they are very small and regularly disposed, so as to form a single row on each segment.

"Entire length, 1.19 inch ; breadth of head, about 0.80 inch ; length of pygidium, 0.44 ; breadth of do., 0.56 ; length of thorax, 0.33 ; breadth of do., 0.60.

"This species is remarkable for the structure of its eyes, which instead of being as usual, covered by the palpebral lobes, have the form and appearance of distinct oval tubercles, with small depressed palpebral lobes merely connecting with their inner sides. * * * * *."

Locality and position.—Warsaw, Illinois ; Keokuk limestone of the Lower Carboniferous series.

We have examined specimens of this species from Warsaw, Ill., now in the Museum of Natural History of New York. The pygidium of these specimens is not a little flattened on the axis or furrowed on its sides, but more round and less broad than that given by Messrs. Meek and Worthen in their figure of the species.

GRIFFITHIDES BUFO, Meek & Worthen.

Plate III, Figs. 4, 5 & 10.

Phillipsia (Griffithides) bufo, Meek and Worthen, 1870 ; Proc. Acad. Nat. Sci. Phila., p. 52.

Phillipsia (Griffithides) bufo, Meek and Worthen, 1873 ; Geol. and Palæont. Illinois, Vol. V, p. 528, pl. 19, fig. 5.

Griffithides bufo, Vogdes, 1886 , Bibliography Palæozoic Crustacea.

The authors give the following description of this species (Geological Survey of Illinois, Vol. V, p. 528) :

"Entire outline elliptical, the breadth being to the length as 75 to 130. Cephalic shield forming more than a semicircle, round in front and nearly straight behind ; posterior lateral angles terminating in short, abruptly pointed spines extending back to the anterior edge of the thoracic segment. Glabella rather depressed convex, wide anteriorly and narrowing posteriorly to the neck-furrow, just in front of which, and connected with the palpebral lobes on each side, it has a single small, obscure lateral lobe ; neck-furrow broad and well defined, both across the glabella and across the posterior margins of the cheeks ; neck-segment rather wide, depressed below the level of the highest part of the glabella in front of it. Eyes of moderate size, reniform, nearly as prominent as the glabella, placed but little in front of the continuation of the neck-furrow across the cheeks, apparently smooth, but showing, when the outer crust is removed, numerous very minute lenses beneath. Cheeks sloping off rather abruptly from the eyes to the thickened

margin, which does not continue around the front of the glabella; facial sutures cutting the anterior margin in front of the eyes before, and a little outside of them behind. Thorax nearly twice as wide as long, distinctly trilobate; mesial lobe but moderately prominent, nearly twice as wide as either of the lateral lobes, its eight segments merely rounded, and without furrows. Lateral lobes narrow; pleuræ curving moderately downwards at less than half their length out from the axial lobe, but not distinctly geniculated, each provided with a furrow extending nearly half way out.

"Pygidium approaching semi-circular with the anterior lateral angles obliquely truncated.; mesial lobe but slightly wider anteriorly than the lateral; segments about eleven; lateral lobes with eight or nine segments. Surface finely granulated, the granules being most distinct on the glabella, and the segments of the mesial lobe of the thorax.

"This species will be at once distinguished from our *P. Portlocki*, from the same horizon, by its much broader and less ventricose glabella, and the peculiar tuberculiform eyes of that species, as well as by the broader and less prominent mesial lobe of the pygidium, in the form under consideration."

Locality and position.—Crawfordsville, Indiana. Keokuk division of the Lower Carboniferous series..

The specimens of this species from Crawfordsville, Indiana, now in the American Museum of Natural History, New York city, Plate III, figs. 4, 5, & 10, have a large pyriform glabella, gibbous, overhanging the anterior border. The spines of the free cheeks extend in one specimen to the third segment of the thorax; Pl. III, figs. 4 & 5.

The ribs of the pygidium are double, and die out before reaching the edge of the pygidium, leaving a comparatively broad smooth margin. The axis is prominent, about the width of the side lobes anteriorly, and narrowing posteriorly to about half its anterior width.

In general this species approaches the *Griffithides globiceps*, Phillips, from the Carboniferous limestone of Yorkshire, England.

The glabella of the American species is rather depressed convex, and slightly overhanging, whereas the English specimen has a very gibbous overhanging glabella. The pygidium of the English species has a broad and prominent axis, gradually tapering towards the posterior margin, whereas the American species has not the posterior portion of each thoracic segment strongly corrugated.

Specimens of *Griffithides bufo* have been examined from the

American Museum of Natural History New York, and from Columbia College, also in the collection of Prof. J. J. Stevenson, of New York University.

GRIFFITHIDES SCITULA, Meek and Worthen.

Plate III, Figs. 11, 12, & 13.

Phillipsia (Griffithides) scitula, Meek and Worthen, 1865; Proc. Acad. Nat. Sci. Phila., p. 270.

Phillipsia (Griffithides) scitula, Meek and Worthen, 1873.; Palæont. Illinois, Vol. V, p. 612, pl. 32, fig. 3.

Phillipsia scitula, Meek, 1872; U. S. Geol. Sur. Neb., etc., p. 238, pl. 6, fig. 9.

Phillipsia scitula, Herrick, 1887; Bull. Sci. Lab. Denison Univ., Vol. II, p. 62.

The original description of this species given by Messrs. Meek and Worthen in the Palæontology of Illinois, Vol V, p. 612, is as follows:—

"Small, entire outline nearly elliptic. Cephalic shield semi-elliptic, very convex, about one-third its breadth wider than long, rounded anteriorly, and nearly straight behind, with posterior lateral angles produced backwards into rather stout, carinated pointed spines, which extend as far back as the fifth thoracic segment. Glabella broadly rounded and sloping in front, where it is without a projecting marginal rim; distinctly contracted posteriorly, in which region it is most elevated; separated from the cheeks on each side by its much greater convexity, and a shallow furrow, which becomes obsolete around the front; posterior lateral lobes comparatively large subtrigonal. very oblique, depressed, and isolated by the strongly defined lateral furrows in front of them being so very oblique, and produced as to intersect the neck furrow; midway between these two lobes there is a a more prominent mesial node, isolated by an accessory furrow passing across the front of it. so as to cut it off. as it were. from the narrow posterior central part of the glabella; second and third lateral lobes very small, transverse, and obscurely defined by short, nearly obsolete linear furrows; anterior lobe larger than all the remaining portions of the glabella between it and the neck furrow.

Neck segment a little higher in the middle, (where it is provided with a minute tubercle), than the glabella. Strongly arched upward (not forward), and more than twice as wide antero-posteriorly as one of the thoracic segments; neck-furrow deep, broad and arched with the neck-segment. Eyes comparatively large, or half as long, and (behind). nearly as prominent as any part of the glabella, located with their posterior margins opposite the neck-furrow, and less than half their own length in advance of the posterior margins of the cheeks; visual surface ventricose, or sub-hemispherical, smooth, or even polished, as seen under a good pocket lens, but when examined by a high magnifying power, showing numerous, regularly dis-

posed, minute lenses beneath the smooth, transparent outer crust ; palpebral lobes semi-circular, convex, and resting upon the eyes like lids.

Cheeks, as compared with the size of the eyes and glabella, small, sloping abruptly from the eyes into the deep broad, marginal furrow, which becomes suddenly obsolete on reaching the anterior lateral margins of the glabella, and extends backwards to or even a little upon the posterior lateral sub-spiniform appendages ; posterior margins with an elevated rim, strongly defined by the deep continuation of the neck-furrow ; lateral margins showing, as seen from above, a narrow rim, which in a side view, is seen to be deep, vertically flattened, and marked by fine parallel longitudinal striæ ; anteriorly it continues around the front of the glabella, but does not project so as to be visible from above, while its upper margin is continued in the form of a carina along the middle of the posterior lateral spines to their points.

Facial sutures cutting the anterior border in front of the eyes, and the posterior margins of the cheeks behind the outer margins of the eyes. Thorax nearly as long as the head, but somewhat narrower, very distinctly trilobate ; mesial lobe prominent, rounded, and a little wider than the lateral lobes ; its 9 segments narrow and sub-angular. Lateral lobes depressed and flattened near the mesial lobe, and so abruptly sloping from the outer side of the flattened space as to impart a slight angularity along that region ; segments corresponding in size with the segments of the mesial lobe, distinctly kneed near the middle, outside of which they are bent down and obliquely flattened for folding together, and rounded at the extremities.

Pygidium very convex, smaller than the cephalic shield, forming more than a semicircle, with anterior lateral angles obliquely truncated ; posterior outline regularly rounded, with a moderately wide, smooth, depressed, nearly flat or sloping marginal zone ; trilobation as in the thorax, strongly defined ; mesial lobe prominent, as wide anteriorly as one of the lateral lobes, including its borders, distinctly flattened on each side, slightly tapering to an obtuse termination less than half its own greatest anterior breadth from the posterior edge ; segments 11 or 12, well defined above, but nearly obsolete on the flattened side.

Lateral lobes convex, but distinctly less so than the mesial lobe, horizontally flattened near the latter, with an angle along the outer margin of the flattened space, from which the sides slope abruptly to the flattened smooth border ; segments 6, simple, geniculated or bent down in the middle very distinctly, but terminating abruptly at the rather wide border ; each with a minute pustule on the knee.

Surface of the glabella, and all the segments, more or less granular, the granules being larger on the posterior part of the glabella and neck-segment than elsewhere.

Entire length 0 60 inch."

Locality and position : Springfield, Illinois. Upper part of

Coal Measures; also Lower Coal Measures of Illinois and Upper Coal Measures of Plattsmouth, Nebraska.

GRIFFITHIDES SANGAMONENSIS, Meek and Worthen.

Plate III, Figs. 7 & 8.

Phillipsia (Griffithides) Sangamonensis, Meek and Worthen, 1865; Proc. Acad. Nat. Sci. Phila., p. 271.

Phillipsia (Griffithides) Sangamonensis, Meek and Worthen, 1873; Palæont. Illinois, Vol. V, p. 615, pl 32, fig. 4.

Phillipsia Sangamonensis, Herrick, 1887; Bull. Sci. Lab. Denison Univ., Vol. II, p. 61, pl. 5, fig. 13.

The description of this species is given by Messrs. Meek and Worthen in their final report, Palæontology of Illinois, Vol. V, p. 615, as follows.

"Entire outline elongate subovate Cephalic shield very convex, forming more than a semicircle, and about one-third wider than long; regularly rounded in front and straight behind, with posterior lateral angles produced into rather broad, carinated, pointed or sub spinous appendages equaling in length the distance from the posterior side of the cheeks to the anterior end of the eyes. Glabella ventricose, very prominent, separated from the cheeks on each side by a moderately distinct furrow, which also passes around the front; most convex behind the middle, thence rounded and declining to the rounded front, about one-fourth longer than wide, and slightly wider between the eyes than anteriorly, sides nearly parallel, but a little sinuous at the middle; posterior lateral lobes comparatively large, subtrigonal or tuberculiform, and entirely isolated by the the distinct lateral furrow passing obliquely across with a backward curve, from opposite the middle of each eye, so as to intersect the neck-furrow; second lateral lobes much smaller and more obscure than those behind, and also oblique, being merely defined by a faint impressed, curved oblique line; in advance of these there are also obscure indications of two short, nearly obsolete lateral furrows, scarcely visible without the aid of a lens. Occipital segment well defined, but lower and considerably shorter in its transverse diameter than the glabella; strongly arched upwards (not forwards), and projecting backwards a little behind the posterior line of the cheeks; neck-furrow distinct, and arched upwards with the occipital, or neck-segment; its continuation along the posterior sides of the cheeks very deep, and nearly straight for about two-thirds of the way across towards the lateral margins, where it intersects another furrow or depression coming around the sides of the cheeks. Eyes lunate, rather large, or nearly half as long as the glabella, exclusive of the neck-segment, prominent, but not as high as the glabella, located about half their own length in front of the posterior margin of the cheeks; visual

surface smooth, or even apparently polished, and showing no traces of lenses under a good magnifier ; palpebral lobes convex, but resting like a lid upon each eye. Cheeks sub-trigonal, declining abruptly from the eyes: lateral margins turned downward, and forming below a sharp edge, which continues back along the lower margin of the posterior spine-like appendages ; above this there is a vertically flattened, or even concave zone or belt, extending from near the front part of the glabella around the outer side of each cheek, and becoming a shallow furrow as it passes back upon the spines along which it seems to be more or less marked nearly to their pointed extremities; between this vertically flattened band and the eyes, there is another nearly horizontally flattened, or outwardly sloping zone extending around each cheek from near the front posteriorly, so as to unite with the lateral connections of the neck-furrows behind, and continues as a single furrow along the upper margin of the posterior spines, thus leaving a more or less defined mesial ridge between these two furrows the entire length of the posterior lateral spiniferous appendages, as well as around the cheeks, to near the front of the glabella ; posterior margins of the cheeks, behind the continuations of the neck-furrow, very prominent, or forming a thickened rim. Facial sutures extending obliquely forward and outward from the anterior side of the eyes; and again curving inwards, so as to cut the anterior margin nearly on a line with the anterior inner extremity of the eyes; from the posterior end of the eyes, directed obliquely outwards and backwards, so as to intersect the posterior margin nearly midway between the neck-segment and the sub-spiniferous lateral posterior append ages.

Thorax only known from a few of the posterior segments, which show the mesial lobe to be wider and distinctly more prominent than the lateral lobes, which are flattened near the mesial lobe, and abruptly deflected downwards near the middle ; segments divided by a furrow near the anterior side from the knee inwards, and flattened in the direction of the axis at the rounded outer extremities.

Pygidium semi-elliptic, slightly wider than long, and rather convex, distinctly narrower and a little longer than the cephalic shield, narrowing backwards, and narrowly rounded at the posterior extremity. Mesial lobe prominent, a little flattened on each side, and narrower than the lateral lobes, from which it is distinctly separated by broad strong furrows; tapering gradually backwards and terminating rather abruptly near one-third its own length from the posterior margin, so as to leave a broad, nearly flat, or more or less sloping smooth border, which extends along each side the whole length of the pygidium, but becomes narrower anteriorly ; segments of the mesial lobe 17 or 18, well defined, rounded, and very nearly or quite straight. Lateral lobes more depressed, and about one third or one-fourth wider than the mesial lobe, rounding down rather abruptly to the lateral margins ; segments 9 or 10, rounded, simple, and separated by distinct furrows ; all terminating abruptly at the inner edge of the broad smooth marginal zone. Entire surface apparently very nearly smooth.

Locality and position—Upper Coal Measures, Springfield, Ill.

Compare *Phillipsia Howi*, Billings, Can. Nat., Vol. VIII, p. 207. This species was described from a pygidium from the Lower Carboniferous beds of Nova Scotia. It has the same semi-elliptic form, a prominent tapering axis, which terminates abruptly, posteriorly, at the marginal border of the pygidium. The axis is marked by 17 or 18 axial rings. The side lobes are depressed below the plane of the axis and marked with 10 or 12 ribs; the first three or four being grooved along their outer portions. This is a greater number than those of the specimen from Springfield, Illinois. The sides of the pygidium are bordered by a marginal rim, which widens out posteriorly; and altogether both in size and form this part approaches closely to that described by Messrs. Meek and Worthen as *Phillipsia* (*Griffithides*) *Sangamonensis*.

GRIFFITHIDES GRANULATUS.

Proetus granulatus, Wetherby, 1881, Jour Cincinnati Soc. Nat. Hist., Vol IV, p. 81, pl. 2, figs. 8, 8*a*, 9, 9*a*.

The following is a copy of the original description of this spe-

"*Body*—General form elongate elliptical, the cephalic, thoracic and abdominal regions being nearly equal in length, the thoracic slightly shorter.

Head—Rounded in front, the angles of the cheeks produced backward into short heavy spines; glabella very prominent, slightly constricted near the centre, surface granulated, lobed posteriorly, occipital furrow well defined; cheeks margined, the margined space longitudinally striated, and much narrowed in front of the glabella; eyes prominent, separated from the glabella by a deep groove, entire surface of the head minutely granulate.

Thorax—Consisting of 10 ? segments, axial lobe very prominent, about equal in width to the lateral lobes, the segments slightly arched forward in the middle, nearly or quite equal in length; lateral lobes about as wide as the central, geniculate, with the extremities of the pleuræ directed backward.

"*Pygidium*—Semi elliptical, consisting of 15 ? segments. Axial lobe prominent, narrower than the lateral lobes, segments not arched, gradually tapering backward to the margin; lateral lobes wider in front, tapering posteriorly, widely margined, the margin continuous and granulated. Length of medium sized specimen, 20 mm.; width across from tip to tip of spines, 10 mm.: length of largest specimen, 26 mm." * * *

Geological position and locality.—Chester series, Pulaski Co., Kentucky."

This specimen approaches very closely the *Griffithides Portlocki,* Meek and Worthen, from the Keokuk series of Illinois.

BRACHYMETOPUS McCoy, 1847.

Plate II, Fig. 13.

Generic description.—General form elliptical. Cephalic shields semi. circular, and slightly pointed, about one-third wider than long . Glabella small, somewhat elevated, one-third the width of the entire head, and about one-half the length, having a basal lobe on each side, but no short lateral furrows on the glabella. Neck-furrow distinctly marked, equal in width to the posterior border of the free cheeks. Eyes small, smooth, equal to half the length of the glabella ; no facial suture visible. Free cheeks slightly convex, nearly twice as long as they are broad, with no visible suture separating them from one another in front of the glabella. Margin broad and slightly grooved, angles of the cheek produced into spines. Thoracic segments not known.

Pygidium consisting of a variable number of segments, from 10 to 17, the axis tapering rapidly to a bluntly rounded extremity. Each segment of the axis ornamented with nodes , ribs with a double furrow extending nearly to the border, which is smooth and rounded.

BRACHYMETOPUS LODIENSIS, Meek.

Phillipsia (Griffithides ?) Lodensis, Meek, 1875, Geol and Paleont Ohio, Vol. 2, part 2. p. 323, pl. 18, fig 3.

The original description of this species described a " rather small trilobite, with an elliptic general outline, the length being somewhat less than twice the breadth , cephalic shield forming rather more than a semicircle, with the posterior lateral angles terminating in acutely pointed spines that extend back to the third thoracic segment ; anterior and lateral margins rounded in outline, and provided with a more or less flattened border, ornamented above with a row of small tubercles, that extend back a little upon the posterior lateral spines, while it is somewhat thickened and finely striated on the under side ; glabella small, longitudinally oval, moderately prominent, separated from the cheeks on each side by a well defined furrow, but without visible lateral furrows of its own (unless there may be a posterior one on each side separating a little tubercle) ; whole surface occupied by about 25 distinct tubercles or coarse granules ; eyes small, tuberculiform, rather prominent, and situated near and opposite the posterior third of the glabella, with the visual surface smooth or very minutely reticulated ; cheeks occupied by comparatively coarse, prominent tubercles, like those on the glabella ; thorax with middle lobe somewhat wider and higher than the lateral, from which it is separated by well-defined furrows ; segments of mesial

lobe ornamented with tubercles, arranged so as apparently to form five longitudinal rows; pleuræ each provided with two nodes, arranged so as to form two rows along each lateral lobe, those of the outer row being a little larger than the others, and situated somewhat within the middle of each lateral lobe at the point where the pleuræ bend to form the slope of their lateral extremities. Pygidium semi elliptic, with length and breadth as three to four, very convex; mesial lobe very prominent and equaling more than one-third the entire breadth of the anterior end, rather rapidly tapering backwards to an obtuse, prominent termination before quite reaching the posterior margin, provided with 12 or 13 segments, each one of which bears five little nodes arranged so as to form five rows, those of the middle row being larger and more prominent than the others, and thus giving the lobe a carinated appearance; lateral lobes somewhat flattened above for about half their breadth, at which point they bend suddenly downward for a short distance, and then obliquely outward to form a rather broad sloping border, each provided with 7 or 9 segments, the posterior of which are obscure and directed nearly backwards, the segments each bearing 2 or 3 little nodes arranged so as to form as many longitudinal rows, and all continued down upon and across the sloping border, at the edges of which they terminate in little pointed projections so as to present a fimbriated appearance around the posterior and lateral edges.

Length, 0.49 inch; breadth, 0.28 inch; length of cephalic shield, 0.20 inch, do. of a pygidium of another specimen from Loudonville, 0.23 inch. in length by 0 30 inch. in breadth, with a height (of mesial lobe) of 0.10 inch.

Position and locality, Cuyahoga shales, at Lodi, Medina Co., Ohio, and Waverly group at Loudonville, Ohio; Lower Carboniferous.

Mr. Meek compares the head of this species with *Brachymetopus MacCoyi*, Portlock, and remarks that "its eyes, however, are proportionally smaller, its occipital ridge much more strongly developed and wider, while the tubercles of its marginal rows are not nearly so crowded as in Portlock's species."

We have examined a specimen of this species from the Cuyahoga shales of Lodi, Ohio, now in the museum of Columbia College. The pygidium is semi-elliptic in form, the axis has 12 segments, with indistinct rows of nodes; the side-lobes are marked with 6 ribs each, extending to the margin of the pygidium.

The pygidium of *Brachymetopus MacCoyi*, has 15 coalesced segments on the axis, each segment having about five small tubercles on the axis, and about as many on the 8 simple lateral lobes; ribs ending abruptly near the margin of pygidium.

PLATES AND EXPLANATIONS.

PLATE II.

Generic Illustrations.

Fig. 1. *Proetus Bohemicus*, Corda.
After Barrande's figure (Sil. Syst. Bohemia, Vol. I, pl. 2, B, fig. 15).

Fig. 2. The same, showing the hypostoma.

Fig. 3. *Griffithides longispinus*, Portlock.
Restoration after Woodward's figure. (Monograph Carboniferous Trilobites, pl. vii, fig. 6.)

Fig. 4. *Phillipsia Eichwaldi*, var *mucronata*, McCoy.
Outline restoration ; (p) position of pores on glabella. After Woodward's figure (Mon. Carb. Trilobites, pl. iv, fig. 15).

Fig. 5. *Griffithides seminiferus*, Phillips.
Dorsal view of one of the thoracic segments. After Woodward's figure. (Mon. Carb. Tril., pl. v, fig. 8*a*.)

Fig. 6. The same.
A section of one of the thoracic segments.

Fig. 7. *Phillipsia trinucleata*, Herrick.
The glabella, from the Waverly Group, Granville, Ohio ; after Herrick's figure. (Bull. Sci. Lab. Denison University, Vol. II, pl. 1, fig. 23 *h*.)

Fig. 8. The pygidium.

Fig. 9. The restored outline as figured by Herrick.

Fig. 10. *Phillipsia gemmulifera*, Phillips.
Restored outline, after Woodward's figure. (Mon. Carb Trilobites, pl. iii, fig. 6.)

Fig. 11. *Phillipsia Derbiensis*, Martin.
A figure of the hypostoma magnified four times ; after Woodward's figure. (Mon. Carb. Trilobites, pl. i, fig. 4 *b*.)

Fig 12. *Griffithides seminiferus*, Phillips.
A figure of the hypostoma enlarged twice, after Woodward. (Mon. Carb. Trilobites, pl. v., fig. 7.)

Fig. 13. *Brachymetopus Maccoyi*, Portlock.
Restored and enlarged figure of this species as given by Woodward. (Mon. Carb. Trilobites, pl. viii., fig. 13.).

PLATE III.

Fig. 1. *Proetus Missouriensis*, Shumard.
A figure of the head, showing the position of the pores, outside of the dorsal furrows of the glabella,—the so-called organs of hearing.

Fig. 2. The glabella, after Dr. Shumard's original figure (Geol. Missouri, pl. B, fig. 13.

Fig. 3. *Proetus ellipticus*, Meek and Worthen.
Outline sketch from the original figure.

Fig. 4. *Griffithides bufo*, Meek and Worthen.
The head enlarged twice, figure drawn from a specimen from Crawfordsville, Indiana, in Amer. Mus. Nat. Hist., N. Y.

Fig. 5. The same, profile view.

Fig. 6. *Phillipsia Stevensoni*, Meek.
Outline sketch of the pygidium twice enlarged. Specimen from the Chester Group, West Virginia, in Prof. J. J. Stevenson's collection.

Fig. 7. *Phillipsia Sangamonensis*, Meek and Worthen.
A copy of the original figure.

Fig. 8. The pygidium, copy of the original figure.

Fig. 9. *Griffithides Portlockii*, Meek and Worthen.
A figure of an entire specimen, twice enlarged, from Warsaw, Illinois. Amer. Mus. Nat. Hist., New York.

Fig. 10. The pygidium of *Griffithides bufo*.
An outline sketch of a specimen from Crawfordville, Ind. Amer. Mus. Nat. Hist., New York.

Fig. 11. *Griffithides scitula*, Meek and Worthen.
Copied from the original figure.

Fig. 12. A side view of the same.

Fig. 13. The pygidium of the same.

Fig. 14. *Phillipsia major*, Shumard.
Outline sketch of the pygidium, of a specimen from Kansas City, Missouri. Columbia College Museum.

Fig. 15. *Phillipsia Meramecensis*, Shumard.
The pygidium, copied from the original figure.

Fig. 16. The pygidium of *Proetus Missouriensis*.
Copied from the original figure.

VII.—*Notes upon a Collection of Myriapoda from East Tennessee, with description of a new genus and six new species.*

BY CHARLES H. BOLLMAN.

Read October 3, 1887.

All the material in this interesting collection represents only two or three hours' collecting by Prof. Branner.

The discovery of a new genus and several new species in so short a time, suggests that an unusually large amount of new material would be brought to light by careful collecting through East Tennessee.

Of the six new species described, one is from the vicinity of Knoxville, (also found at the other localities), one from Mossy Creek, and four from Beaver Creek, Jefferson County.

The new genus is from the latter place.

The types of the new species belong to the Museum of the University of Indiana, and are there deposited.

A.—KNOXVILLE, KNOX CO.

All the specimens from this locality were collected on May 21, 1887, in the woods about one mile south of the river at Knoxville, near the Maryville road.

1. *Parajulus Pennsylvanicus* (Brandt).

Three females were obtained.

2. *Lysiopetalum lactarium* (Say).

Lysiopetalum eudasum McNiell, Proc. U. S. Nat. Mus., 330, 1887 (Bloomington, Ind.).

The collection contains one female, which agrees in all respects with the types of *eudasum*.

3. *Chætaspis albus* Bollman.

Chætaspis albus Bollman, Ent. Amer., III, 46, 1887 (Bloomington, Indiana).

I can find no difference between the types of this species, and the single female obtained.

4. *Polydesmus Canadensis* Newport.

The collection contains three females, which I refer to this species, until males can be obtained.

5. *Fontaria* sp.

I place here two young females, which I cannot identify with any of the known species of *Fontaria*.

6. *Geophilus umbraticus* (McNiell).

Very common. These specimens differ very slightly from the types in the Museum of the Indiana University.

7. *Scolioplanes ruber* Bollman.

One specimen obtained.

8. *Scolopcryptops nigridius* McNiell.

Only one specimen obtained.

9. *Cryptops hyalinus* Say.

A few small individuals were found.

10. *Lithobius Branneri*, sp. nov.

Sub genus *Archilithobius*.

Light chestnut brown or orange, head and antennæ scarcely darker, feet orange. Slender, smooth, very sparsely pilose, head rounded-triangular, narrowest before. Antennæ short, joints 20, short. Ocelli 6—8, arranged in four or five rows. Prosternal teeth 4, small. Coxal pores 2,3,3,2—3,4,4,3, small and round. First pair of feet armed with 0, 2, 1 spines, penultimate with 1,3,1,1—1,3,2,1 ; last with 1,3,1,0 ; in the male its fifth joint is produced into a short pilose lobe, and is depressed. Claw of the female genitalia short, wide, bi- or tri-partite; spines slender, subequal, outer strongly toothed.

Length of body, 5—10 mm.

Four males and three females were obtained. This species is dedicated to Professor John C. Branner, by whom the collection was made.

11. *Lithobius provídens*, Bollman.

A single specimen was obtained.

B.—BEAVER CREEK, JEFFERSON CO.

These species were taken in open cedar thickets from May 21 to 26, 1887.

1. *Andrognathus corticarius* Cope.

Andrognathus corticarius Cope, Proc. Amer. Philos. Soc. 181, 1869 (Virginia).

Fifteen specimens of this species were obtained. They agree in most respects with Dr. Cope's description, but this genus will not form the new family *Andrognathidæ*, which he has set up for its reception. This genus belongs to the sub-family *Dolistenia*, and will somewhat modify the character of that group as given by Dr. Latzel.

2. *Lysiopetalum eudasum*, McNiell.

3. *Striaria granulosa*, gen. et sp. nov. (*Chordeumidae*).

STRIARIA.

Body cylindrical, strongly resembling a *Lysiopetalum*.

Dorsal plates, excepting the last, with twelve strong carinæ, 6 on each side of the median line; between these there are 1—4 rows of round granular dots. First dorsal segment large, advanced forward and covering part of the ocelli; the carinæ are apparently of the same number as the others, while the granular dots are more numerous.

Last segment produced into a broad lobe, while the spines are short and wide, thus making the last segment appear as if incised. Ocelli present.

Feet short and thick.

To the above generic characters may be added the following specific.

Grey-brown, first dorsal segment and feet pale.

Robust, very slightly depressed, everywhere slightly granulated; body, with the exception of a setigerous granular dot between the first and second rows of carinæ, not pilose; feet sparsely pilose

Ocelli present. ' Repugnatorial pore not discernible.
Feet granulated, 44 were counted.
Length of body, 12 mm.: width, 1.5 mm.

The above descriptions were taken from a single female, which is curled in a spire, so that nothing of the head can be seen, except a few ocelli. The pairs of feet were counted with uncertainty, some being probably hidden by the first dorsal segment.

This new genus may be distinguished from all previously known by the characters of the dorsal segments.

4. *Campodes flavicornis* Koch.

Seven specimens were obtained, which agree with the more northern examples.

5. *Craspedosoma carinatum*, sp. nov.

Brown, feet pale, antennæ dark, the joints tipped with white
Body rather slender, depressed, somewhat attenuated.
Antennæ about one-half times as wide as body, sub-clavate.
Ocelli distinct, triangular, 16, arranged in 4 rows. Dorsal plates with numerous short carinæ, lateral plates distinct.
Length of body, 6 mm.; width, .5 mm.

This species is described from a male and a female not quite full grown.

6. *Euryurus erythropygus* (Brandt)

Common.

7. *Geophilus umbraticus* McNiell.

Very common.

8. *Geophilus perforatus* (McNiell).

Schendyla perforata McNiell, Proc. U. S. Nat. Mus., 325, 1887 (Pensacola, Fla.).

Two specimens were obtained.

9. *Scolioplanes bothriopus* (Wood).

Only one specimen.

10. *Scolioplanes ruber* Bollman.

11. *Scolioplanes gracilis*, sp. nov.

Frontal plate present

Orange, head and antennæ brownish. Slender, strongly attenuate anteriorly, less so posteriorly ; smooth, sparsely pilose, feet more densely.

Prehensorial feet sparsely pilose ; sternum subcordiform, wider than long (5 : 2 3); coxa twice as wide as long, unarmed ; last joint unarmed ; claw moderately curved, excavated beneath, as long as the head is wide Cephalic plate sub-quadrate, of almost equal length and width, posterior margin concealed by basal plate ; prebasal plate concealed ; basal plate four times as wide as long (4.5 : 1.2)

First pair of feet short, anterior and posterior sub equal.

Posterior coxa rather strongly inflated, pilose ; pores few, large and small, placed in two irregular rows along the ventral plate, which is very wide, sides rapidly converging and sub-straight. Last pair of feet of male rather slender, armed ; of female somewhat more slender and armed.

Pairs of feet of ♂, 80 : of ♀, 83

Length of body ♂, 34 5 mm., width, .5 mm ; ♀, 53.5 mm., width, 1.4 mm

This species ought to form a new genus, but having only an adult female and a young male, I have not been able to examine the mouth-parts.

It differs from *Scolioplanes* in the characters of the cephalic plate, prehensorial feet, and the last ventral plate and pair of feet.

12. *Scolopocryptops sexspinosus* (Say).

Specimens from this locality, as well as those from more southern ones, differ in some important details from the northern specimens, principally in having the last pair of legs more slender, and the last ventral plate narrower ; but these characters do not seem to warrant the formation of a different species.

13. *Scolopocryptops nigridius* McNiell.

14. *Theatops crassipes* (Meinert).

Two specimens obtained, which agree with specimens from Florida.

15. *Cryptops hyalinus* Say.

16. *Lithobius Branneri* Bollman.

Four specimens were found here.

17. *Lithobius cæcus*, sp. nov.

Sub-genus *Archilithobius*.

Orange, head and last segments dark feet and antennæ scarcely paler.
Rather slender, smooth, sparsely pilose, head subrotund, longer than wide.
Antennæ rather long, joints 31, short.
No trace of ocelli, but darker colored in the place where they ought to be.
Prosternal teeth 4
Coxal pores 2,3,4,3, round
Spines of the first pair of feet, 2,2,1, penultimate, 1,3,2,0; last, 1,3,1,0.
Last pair of feet moderately long
Claw of the female genitalia long, bilobed; spines slender, inner shortest.
Length of body, 10 mm

18. *Lithobius Lundi*, Meinert.

Two specimens obtained.

19. *Lithobius providens* Bollman.

20. *Lithobius Cantabrigensis* Meinert.

21. *Lithobius multidentatus* Newport.

Two specimens obtained.

C. MOSSY CREEK, Jefferson County.

The species from this locality were taken in the woods half a a mile north-west of the railway station, May 22, 1887.

1. *Parajulus Pennsylvanicus* (Brandt).

2. *Geophilus umbraticus* (McNiell).

3. *Scolopcryptops nigridius* McNiell.

4. *Cryptops hyalinus* Say.

5. *Lithobius Branneri* Bollman.

Two specimens obtained.

6. *Lithobius similis*, sp. nov.

Sub-genus *Archilithobius.*

Brown, head and last segment orange; antennæ dark, feet somewhat paler.

Moderately robust, rough, sparsely pilose; head subrotund, length and width subequal.

Antennæ short, joints 21, short

Ocelli 16, arranged in 6 rows,

Prosternal teeth, 4.

Coxal pores, 4,5,5,5, large and round.

Spines of the first pair of feet, 1,2,1, penultimate, 1,3,3,1; last, 1,3,1,0.

Posterior feet moderately long.

Claw of the female genitalia moderately short, wide, tripartite, lobes short; spine short and stout.

Length of body, 11 mm.

This species is described from one female; it is related to *pullus*, but differs from the latter in the characters of antennæ and the claw of female genitalia.

7. *Lithobius providens*, Bollman.

University of Indiana, Entomological Laboratory,
June 8, 1887.

VIII.—*On the Structure and Relations of Edestus, with a Description of a gigantic new Species.*

BY J. S. NEWBERRY.

Read January 16, 1888

The first of the remarkable group of fossils now included in the genus *Edestus*, was brought to the notice of scientists by Dr. Joseph Leidy, in his description of *Edestus vorax*; Journal of the Academy of Natural Sciences of Philadelphia. Series 2, Vol. III, p. 159, Pl. XV, 1856. The type-specimen was only a fragment of an organ that must have had a length of a foot or more, by four inches in width and one and a half inches in thickness. The portion figured by Prof. Leidy, seems to have come from about the middle, and consists of a mass of bone composed of a series of segments, each one of which carries at its upper margin an enameled, compressed, triangular, crenulated denticle, one and a half inches in height and breadth. In general aspect these denticles considerably resemble the crenulated teeth of *Carcharodon*, but with this marked difference; that like all the cutting teeth of sharks, these latter are flattened on one side and arched on the other, and terminate below in a bony base that had only a ligamentous attachment to a cartilaginous jaw; hence in death and decomposition the teeth were generally separated and scattered. In *Edestus*, however, the denticles are firmly anchylosed to a bony support.

At the meeting of the American Association held in Providence in 1855, another and quite different species of *Edestus* was exhibited by Prof. Edward Hitchcock, and was considered by him to be "the jaw of a shark, but of very peculiar character." Prof. Louis Agassiz, who was present, examined the specimen and gave it as his opinion that it formed a part of the jaw of a shark allied to the saw-fish. He stated that "the sword of *Pristis* is originally composed of two bones, and if these

should continue separated, each part with teeth only on one side, would not be much unlike the fossil." He suggested that the fish had a corresponding jaw projecting from the opposite side of its head, and that both formed a powerful weapon of offence. He regarded it as belonging not only to an undescribed genus, but to a new family of fishes.

This specimen was obtained by the Rev. John Hawks, in Park County, Indiana, "in a layer of shale overlying a coal seam." Subsequently it was submitted by Dr. Hitchcock to Prof. Richard Owen, of London, who discusses its relations on p. 194 of his Palæontology, second edition, and gives a bad figure of it. Prof. Owen decided that it was not a jaw, but a defensive spine.

In 1866 I described in Vol. II, of the Geology of Illinois, p. 84, a portion of what proved subsequently to be a fragment of a spine similar to that exhibited at Providence by Prof. Hitchcock, giving to it the name of *Edestus minor*. A figure, taken from a photograph of a nearly complete specimen of this species, was published in Vol. IV, of the Illinois Report, Pl. I, fig. 2, though wrongly named on the opposite page of explanations, *Edestus vorax*. In the same volume, p. 350, was published a description of a third species of *Edestus*, *E. Heinrichsii*, and a half-size figure is given on the plate cited above. To these three species, I now add a fourth of gigantic size, which I have named *Edestus giganteus*, and give in this memoir a description and figure of it.

The geographical distribution of these species of *Edestus* is somewhat peculiar. The first specimen described (*E. vorax*) was obtained from the Coal Measures of Arkansas; the second (*E. minor*), from Park County, Indiana; the third (*E. Heinrichsii*), from shale over coal at Belleville, Illinois, and the specimen of which a description and figure are now published is from the coal-shale at Decatur, in the same State. I should also say that I have other specimens of *E. Heinrichsii*, from Vermillion Co., Indiana. Thus it will be seen that all the specimens known, now quite numerous, are from the Mississippi coal field; that is, the coal area of Illinois and Missouri, once continuous, but now separated by the erosion of the immediate valley of the Mississippi.

In Ohio and Pennsylvania, much more extensive excavations in the coal rocks, and numerous collections of Carboniferous

fossils have been made, but not a trace of *Edestus* has been found there. Hence we must infer that it never passed the highlands of the Cincinnati arch, which separated the western from the eastern coal basins.

The material in which the spines of *Edestus* are found, is almost without exception the bituminous shale which occurs so frequently interstratified with the other elements of the coal measures, and very frequently resting upon coal.

From the black shale which forms the roof of a coal-mine at Belleville, Illinois, Mr. Alexander Butters, the superintendent of this mine, has taken hundreds of the segments which once composed the spines of *E. Heinrichsii.* This shale is apparently a fresh-water sediment, carbonaceous mud which accumulated in the lagoons of water that occupied portions of the coal marshes ; either following a subsidence, and then covering the coal, or synchronous with the peat from which the cubical coal is derived. In the latter case, the amount of earthy matter associated with the carbon is less, and we then have cannel coal. Some of these lagoons must have been of large size, and may perhaps have commuicated with the ocean, for the fishes which bore these defensive and offensive weapons were of enormous size, and could not have been restricted to very narrow quarters, since they required a vast amount of food for their subsistence.* The associated fossils include a large number of fish-teeth, some of which belonged to carnivorous sharks, as *Cladodus* and *Petalodus*, and others with crushing teeth as *Orodus*, *Orthopleurodus*, etc. The habitat of *Edestus* would therefore seem to have been somewhat similar to that of *Rhizodus* and *Megalichthys*, of which the teeth, scales, etc., are so common in the coal-shales and cannels of England and Scotland.

In the Geological Magazine, Vol. XXIII, (1886), p. 2, Prof. Henry Woodward describes and figures a fossil from the Carboniferous rocks of Australia, to which he gives the name of *Edes-*

* That is, if the fishes which bore the spines of Edestus were carnivorous, This is not certain, though highly probable. Vegetable eating sharks, of which there may have been some in ancient times, would need defensive spines even more than those which, like *Cladodus* and *Hybodus*, had teeth that were effective defensive and offensive weapons

tus Davisii. It is the impression of a bony arch about four inches long, on the convex border of which are set fourteen acute, compressed, lancet-shaped, crenulated denticles. It is more curved than the other described species of *Edestus*, but is so like them that Dr. Woodward seems to have been fully justified in placing it in that genus. In his discussion of the structure and relations of this fossil, Dr. Woodward compares it with the segmented spines of *Pelecopterus*, Cope, from the Cretaceous rocks of Kansas, and is thereby led to consider it a pectoral defensive spine. There are, however, some points in the structure of this and other species of *Edestus*, which will be alluded to further on, and which make it difficult for us to accept this conclusion.

In August, 1887, Miss Fanny R. M. Hitchcock, an earnest and accomplished student of comparative anatomy, read a paper before the Biological Section of the American Association "On the homologies of the so-called spines of *Edestus*," in which she suggests that *Edestus* was an intermandibular arch of bone carrying teeth, and most like the dentigerous arch which was held between the extremities of the mandibles in the great Crossopterygian Ganoid, *Onychodus sigmoides*, found in the Corniferous limestone of Ohio, and described by the writer in the Palæontology of Ohio, Vol. I, p. 299, Pl. XXVI, figs. 1-5, Pl. XXVII, figs. 1, 2. There are perhaps no facts which disprove this hypothesis, and it is worthy of respectful consideration, but I would suggest that *Onychodus* was a highly organized Ganoid and very widely separated zoologically from *Edestus*, which must have been a Plagiostome. At least, unless the skeletons of huge fishes like *Edestus giganteus* were cartilaginous, we should find their bones in the rocks where their spines are so numerous.

The structure and probable functions of *Edestus* have been discussed by the writer at some length in the notes on *E. Heinrichsii*, in the Geology of Illinois, Vol. IV, p. 350; and the conclusion is there reached that it was not a jaw, but the defensive dorsal spine of a plagiostomous fish. The considerations which lead me to this conclusion are briefly as follows:

1. Although the denticles which crown the convex border of *Edestus* have the general form and crenulation of the teeth of *Carcharodon* and *Hemipristis*, their structure is in many respects quite different, viz., the teeth of none of the sharks are

symmetrical, one face is flattened and the other is more or less arched ; while the denticles of *Edestus* are equally arched on both sides.

2. The teeth of sharks, while having an enameled crown, have a tumid, bony base attached by ligament to the cartilaginous jaws, and separating readily from them ; hence they are rarely found in place in the fossil state. The denticles of *Edestus*, on the contrary, are firmly attached to the bony arch from which they rise.

3. The form of these fossils is quite unlike that of any jaw of fish, reptile, or mammal known ; being roughly rounded at the base, the opposite extremity flattened and bordered on one side by a sharp edge, on the other by crenulated denticles, one of which is terminal.

4. The rounded roughened base proves that this organ could not have been articulated with any bones and scarcely with cartilages ; else we should have some evidences of coadaptation. In this respect it resembles most the dorsal spines of sharks and skates, which are implanted in the integuments of the back and have a roughened base and bony structure, with various forms of enameled denticles on one margin.

5. If the spines of *Edestus* were attached to the head, as modified jaws and the homologues of the rostrum of *Pristis*, the base would present some evidence of anchylosis with the bones or cartilages of the head ; whereas it is rounded as though it had been buried in soft tissue. Again, the rostrum of *Pristis* is only partially ossified, while the spines of *Edestus* are composed of dense bone ; and, further, the denticles of the rostrum in *Pristis* are set in alveolar cavities, from which they escape and are scattered about in the decay of the animal. We often find these denticles in the Cretaceous marls, but almost always isolated, like the sharks' teeth which occur with them. On the contrary, the denticles of *Edestus* are inseparably united with their bony bases, and they are perfectly preserved together. Finally, if each spine of *Edestus* was one of a pair attached to the snout, like the rostrum of *Pristis, Xiphias,* or *Cœlorhynchus,* they must have been entirely separated, for they bear no marks of contact, and they would certainly have been unsymmetrical. We are therefore, driven by the bilateral symmetry of *Edestus* to conclude that it was not one of a pair, but that it stood alone

somewhere on the median line, as a homologue of either the intermandibular arch of *Onychodus*. the dorsal spines of *Chimaera* and *Hybodus*, or the caudal spine of *Trygon*.

The suggestion of Miss Hitchcock, that *Edestus* is an intermandibular bony arch carrying teeth, is not incompatible with its bilateral symmetry; but we here meet the difficulty already suggested, that *Onychodus*, the only fish known which had such an intermandibular arch of bone, was a scaled Ganoid allied to *Polypterus*, and has left abundant bones besides its intermandibular arch In *Onychodus sigmoides* of the Corniferous limestone, and *O. Hopkinsii*, of the Chemung group, the teeth are not anchylosed to the arch, are almost always found detached, and the sides of the arch are compressed between the extremities of the mandibles. In *O. Ortoni*, of the Huron shale, the teeth are implanted in the bony arch as a post is set in the ground, and the arch is not distinctly impressed by the extremities of the mandibles. The type-specimen of *O. Ortoni* is yet unique, and we know nothing of the other parts of the fish which bore it. It is of course not impossible that this singular form of dentition might have been borrowed by some plagiostome which used it to accomplish a similar function; but no facts are yet known to warrant this supposition.

Edestus Davisii is more like the intermandibular crest of *Onychodus* than are the other species of the genus. It is much more curved, and the arch of bone from which the denticles rise is laterally compressed or longitudinally grooved. Taken by itself, it renders the suggestion of Miss Hitchcock quite plausible. But it cannot be taken by itself, for wherever that species goes, *E. minor*, *E. Heinrichsii*, and *E. giganteus* must follow, and while we can imagine a fish ten feet long with an arch of bone like *E. Davisii* held between the extremities of the mandibles, it requires a much greater stretch of the imagination to conceive of a shark of such size that this relatively insignificant organ was twenty inches long and seven or eight inches wide. Certainly such a monster would seem very much out of place in the lagoons of the coal marshes. Again, *E. Heinrichsii* is nearly straight, a foot long, rounded and massive at one end, thin and acute at the other: but the succession of denticles was by additions at the acute end, which must have been behind, and if it was situated in the symphysis, the blunt rounded end would

have formed the apex of the arch of the lower jaw—a condition of things scarcely comprehensible.

If now we transfer this spine to the position of the post-dorsal fin, and bury it in the soft parts all except the denticles, the elongation backward by the successive addition of sheaths and denticles becomes intelligible and natural.

There are some anomalous features in this fossil which require notice, viz., there is no distinct line of demarcation between an exposed and a buried portion, such as we find in most of the defensive spines of sharks, unless, as seems probable, all the shaft was buried, and only the denticles exposed. Another peculiarity is the absence of the medullary cavity found in most dorsal spines of sharks. This is quite conspicuous in the spines of *Hybodus, Ctenacanthus,* etc.; but in the rays the spines are solid, and there is little distinction between the exposed and buried parts. The exceptional characters just mentioned need not therefore, be considered incompatible with the view that these fossils are spines.

The segmented structure of *Edestus* is its most marked and anomalous feature, but one equally so whether it be considered spine, jaw, rostrum or intermandibular arch. It is undoubtedly to this structure that we must ascribe the absence of a large medullary cavity, as each segment bearing a denticle seems to have been nourished independently of its fellows. It is also apparent that the growth of this organ was by additions to the summit of successive sheaths, each of which carried a denticle. This is strikingly different from the mode of growth of all sharks' spines known, as these increase by additions to the base, and are thus pushed upward and lengthened. The same is true of all rostra which are used as weapons of defense or offense. If we consider the segments of *Edestus* as homologues of a dental series, we encounter the same difficulty. A row of teeth of *Orodus*, for example, which consist of enameled crowns with flattened bony bases lying in contact and compressed together, considered as a whole presents considerable analogy with our fossils; but there too the growth is from behind forward, new teeth moving up to take the places of such as are broken or worn away. The numerous disconnected segments of *Edestus Heinrichsii* furnished me by Mr. Butters seem to prove conclusively that the spine was elongated by the addition of a sheath carrying a denticle to the extremity and under-side of the pre-existing

series, as shown in figs. 2 *b* of Pl. V. I also have from Vermillion Co., Indiana, a specimen figured on Pl. V fig. 2 *a*, which seems to be the basal segment of a spine, probably of a young individual, of *Edestus Heinrichsii.* This is a spatulate solid bone carrying a beautifully perfect enameled denticle at its extremity. The shells or sheaths obtained from Mr. Butters are similar to this, except that each one is a trough into which the succeeding one fits, and the added cap covers a portion of the enameled base of its predecessor. If this is all true, and it seems undeniable, we are compelled to conclude thas the spine was buried in the integuments throughout its entire length ; the enameled denticles alone projecting above the surface to form a saw which would be a terrible weapon, if placed upon some flexible portion of the body where it could be used with freedom and power. The extremity of the spine may have lain in a sheath from which it could be partially erected by muscular action, and used as the lancet of the surgeon fish (*Acanthurus*) is ; but the bilateral symmetry of *Edestus* proves that if employed in this manner it must have been located on the upper margin of the tail or back.

The segmented structure of *Edestus* has led Dr. Woodward to compare it with the segmented spines of *Pelecopterus*, and especially with the pectoral spines of this genus described by Prof. E. D. Cope, (Geol. Survey of the Territories, Vol. II, p. 244 A)., but the symmetry of *Edestus* forbids the acceptance of this conclusion. The pectoral spines of all fishes are unsymmetrical. This is plainly seen in *Machæracanthus* and *Gyracanthus*, and, as I have lately shown, in the pectoral spines of *Stethacanthus* (*Physonemus*) *Altonensis*. *Pelecopterus* probably had dorsal as well as pectoral spines, and a comparison with them would be better grounded ; but as that was a bony fish, the dorsal spines would have an articulation at base, and would have grown at the base and not at the summit.

In the spines of *Trygon*, however, we find a much closer resemblance to *Edestus* ; one that seems to me to go far towards solving the problem of the relations and functions of these peculiar organs, and almost decides that they are dorsal spines. In *Trygon* a considerable number, sometimes five or six, defensive spines are set in the place of the posterior dorsal fin. They come into use in succession, like the fangs of venomous serpents.

As the anterior one loses its denticles or becomes worn or broken, it falls, and is succeeded by another *from behind.* Yet several may be in existence and effective at the same time, all arising from a common segmented bony base which grows by additions to its posterior extremity* All this is true of the spines of *Edestus*, if we are right in locating them in the position of the second dorsal fin on the back or tail of a plagiostome fish.

Hence until further light shall be thrown upon the interesting question of the homologies and functions of *Edestus*, we may regard them as the post-dorsal spines of large cartilaginous fishes, of which the other parts are yet unknown, and may suppose that they were used for attack and defense, like the spines of *Trygon* or *Acanthurus*.

* On the tail of *Heliobatis*, Marsh, a fresh-water ray from the Eocene Green river beds of Wyoming, I have seen three spines which must have been in service at the same time.

EDESTUS GIGANTEUS, sp. n.

Plate VI, Fig. 1.

Spine very large, 18 inches or more in length, by 7½ inches in breadth to top of denticles, and 2 inches in thickness at centre; form strongly arched, section spatulate in the middle, lenticular at base; lateral surfaces of bony portion vermicularly roughened; segments narrow, running far back, about ¾ of an inch wide, in the middle of the spine 10 inches from summit of denticle to lower margin; denticles 3½ inches long by 2¼ inches wide at base, triangular in outline, crown about as broad as high, base prolonged backward and downward into a simple curved point; margins set with 15 to 18 strong, rounded, sharp, compressed serrations.

This remarkable spine differs from the other species of the genus not only by its greater size, but by the form of its enameled denticles. It approaches nearest to *Edestus vorax*, Leidy, described in the Proceedings of the Academy of Natural Sciences, Philadelphia, Vol. VII, p. 414, and in the Journal of the Academy, Second Series, Vol. III, p. 159, Pl. XV, but is distinguished from that species by its larger size, more prolonged segments, and especially by the outline of the bases of the

denticles. In *E. vorax*, the lower margin of the enameled surface of the denticle is nearly horizontal and is rounded behind, with a deep notch. In the species before us, on the contrary, the enamel runs down obliquely backward to an acute point, from which it sweeps upward by a gentle curve, forming a shallow sinus, to the base of the posterior row of serrations.

From *Edestus Heinrichsii*. N. & W., (Geology of Illinois, Vol. IV, p. 350, Pl. I, fig. 1), it differs by its greater size, more curved form, more oblique denticles, and the shorter posterior point of the base of the enamel.

From *Edestus minor*, Newb., (Geol. of Illinois, Vol. II, p. 84, Pl. IV, fig. 24, and Vol. IV, Pl. I, fig. 2,—wrongly named on the opposite page of explanations *Edestus vorax*), it differs in its much greater size and the far broader and less decurrent denticles; as will be seen from the figures now given, reproduced from photographs of the two last mentioned species.

Formation and Locality.—Coal measures, Decatur, Mason County, Illinois. Collected by Mr. H. A. Wheeler, of Washington University, St. Louis, to whom I owe the opportunity of examining and describing it.

EXPLANATION OF PLATES.

Plate IV.

Fig. 1. *Edestus Davisii*, Woodward; Australia.
" 1*a*. Transverse section of same.
" 2. *Edestus vorax*, Leidy; Arkansas.

Plate V.

Fig. 1. *Edestus minor*, Newb.; Park Co., Indiana
" 1*a*. Section near base of a larger spine of same.
" 2. *Edestus Heinrichsii*, N. and W., Belleville, Ill.
" 2*a*. First segment, young spine of same.
" 2*b*. Portion of later segment forming sheath.

Plate VI.

Fig. 1. *Edestus giganteus*, Newb.; Decatur, Illinois.

All the figures of natural size.

IX.—*On an Archæan Plant from the White Crystalline Limestone of Sussex County, N. J.*

BY N. L. BRITTON.

Read, January 9, 1888.

The abundance of graphite in certain Archæan limestones, and notably in those referred to the Laurentian system, has often been cited as an indication of the existence of plant-life at that remote period, and indeed, has seemed to the writer and others attributable to no other source, although this view has not found ready acceptance in the minds of many geologists. The mineral generally occurs in these limestones in the form of scattered separated flakes or small masses, often somewhat crystalline in outline, thus affording neither information regarding the nature of the plant from which it has been derived, nor certainty that it is in reality of vegetable origin. Through a fortunate discovery made last September by Mr. J. I. Northrop and myself, I am able to submit evidence that in one belt of Archæan limestone in the Highlands of New Jersey, the graphite has been derived from a plant, and proof that vegetable life existed in that epoch.

There are two known limestone belts in the New Jersey Highlands. The one is in the eastern part of the area, extending in isolated outcrops from Mendham, Morris County, northeast through Passaic County to Ringwood, and in New York through Orange County to the Hudson. This contains some graphite, but is especially characterized by serpentine and other magnesian minerals. The other has its southwestern exposures in Warren County, extends through Sussex County, and is also known for a considerable distance in Orange County, New York.

Perhaps its most marked feature is its mineralization at certain points with manganese, zinc and lead,—the great mines of Ogdensburg and Franklin Furnace being enclosed by the limestone. While its northeastern portion is mainly a broad continuous outcrop, it is greatly broken to the southwest, forming by faulting, as we suppose, detached areas of limited size, occurring in the most unexpected positions.

One of these little areas furnishes the specimens to which attention is here directed. The plant-remains appear as black bands on the rock, consisting of very thin films of graphite; in some the thickness reaches about 0.5 mm., but it is generally less. The average width of the bands is about 3 mm., and the greatest continuous length observed about 6 cm., though it is apparent that when entire they were much longer. In many parts of the rock these are matted together to form broad, black patches, which are in reality thin carbon strata. The bands and films lie parallel with the bedding of the limestone. No cellular structure has thus far been detected.

As this is undoubtedly the most ancient plant yet discovered, I should suggest for it the generic name ARCHÆOPHYTON; and to acknowledge in an imperfect manner my obligation to one to whom I am indebted for encouragement and counsel in study and investigation, and at the same time to associate with this interesting plant the name of one foremost in American Palæobotany, I would denominate the plant ARCHÆOPHYTON NEWBERRYANUM.

While the imperfect nature of the fossil forbids any definite statement as to its botanical affinity, we may, perhaps, assume its relation to the algæ.

The general aspect of the specimens is well shown in the accompanying figure (Plate VII.).

VIII.—*On the Variation of Decomposition in the Iron Pyrites; its cause, and its relation to density.*

BY ALEXIS A. JULIEN.

PART II.

Continued from Vol. III, page 404.

Read April 18th, 1887.

We have thus far considered ordinary forms of decomposition of the natural iron-sulphides, and also the principal facts known as to their close association, intermixture, and mutual replacements. There are local conditions, however, of extreme exposure to the atmosphere, or of protection from its action, which in many instances appear to affect the stable character of varieties of these three minerals. The following example of the latter has been communicated to me by Prof. D. S. Martin.

"As to the two forms of pyritous decomposition, I have observed them especially in the nodules from the clays at Cliffwood, N. J., opposite Keyport. Those on the beach, washed out of the bluff and exposed to the salt water, are limonite-coated and permanent; while those uncoated, taken out of the bank and brought home, cannot be preserved, splitting up and going into vitriol, with a development of free acid that eats through any cotton, paper, or pasteboard. Sometimes those on the beach are coated on their upper, exposed surfaces, and not on their lower sides, or only partially, leaving spots or portions that in time become starting-points for the vitriolic decomposition."

In this instance we have simply evidence of decomposition of

the efflorescing vitriol by reaction with salts of the sea-water, the deposit of hydrated iron-oxide, and the partial or complete protection of many nodules from further oxidation, by envelopment in a limonite-crust, and by its infiltration into their pores.

In few cases on record can we trace a distinct connection between an unusual facility of decomposition, in a variety of pyrite, and the presence of another metallic sulphide: e. g., the cupriferous variety[1] from Cornwall, Lebanon County, Penn., of which it is stated,[2] "it tarnishes readily, assuming the blue tarnish of steel." But we have now to consider another class of facts, of entirely different nature and general occurrence, which bear on the stability of the same mineral, independent of any peculiar local conditions.

I. On the Variation of Stability in Pyrite.

The general tendency of this mineral to oxidation, on exposure to moist air, is so characteristic and so quickly apparent to the most unskilled, and the varieties of pyrite possessing it are of so wide and abundant occurrence, that the existence of the stable variety is not as yet familiarly known.

A. Instances of Resistance to Decomposition.

These occurrences, though well marked and brought to the notice of many mineralogical students and collectors, have been rarely recorded and never collated. A late reference to the subject has been made by Dr. J. S. Newberry:[3]

"A peculiarity of this mineral is the readiness with which some specimens oxidize, while others, apparently similar in all other respects, remain brilliant. Few more beautiful minerals ever enter a collection; but many of the specimens of pyrite in the cabinet of the School of Mines, particularly those from Schoharie, N. Y., decomposed rapidly, absorbing oxygen and water, thus forming sulphuric acid, which has destroyed labels and trays, and has even cut through the bottom of the drawer

[1] Analysis No. 25, Part I of this paper, Ann. N. Y. Acad. Sci., (1886), III, 377.

[2] J. D. Dana, System of Mineralogy, (1883), 63.

[3] Trans. N. Y. Acad. Sci., (1883), II, 138-139.

in which they were placed. Others, like those from Roxbury, Conn., and from certain gold mines of Colorado, have remained unchanged, though for years lying in a room over the chemical laboratories. No facts in chemical geology were more interesting and mysterious than those connected with pyrites: such as its close companionship with gold, the conditions of which have not been determined; its unchangeableness in some cases, its destructibility in others. Sometimes its crystals or concretions are completely changed to limonite, with not the least change of form or markings; sometimes, by oxidation, it is converted into sulphate of iron, which is washed away, leaving cubical cavities, or a spongy mass of quartz; and sometimes even the iron has disappeared, leaving the cavities lined with sulphur. These differences have not yet been satisfactorily explained, and they constitute an inviting subject of investigation for the chemist and mineralogist. Dr. Newberry had noticed that the pyrites so common in coal, and pyrite replacing wood, are particularly prone to oxidation; the concretions in clay are liable to it, and the brilliant crystallizations in mineral-veins and in metamorphic slates, less so." The fact of the resistance of a form of true pyrite to decomposition has been known to many mineralogists, and is thus strongly stated by some authors, usually without attempt at explanation: "It does not decompose in a moist atmosphere."[1] "The faces of its crystals are very brilliant, the action of the air does not tarnish them."[2]

"Pyrite is not altered in the air, and does not decompose in collections."[3] "The oxidation of pyrite is a very subordinate phenomenon on the Comstock. It is well known that various occurrences of pyrite differ greatly in their behavior toward oxidizing agents. That found on the Comstock is for the most part very stable, and often remains exposed for years with no greater effect than tarnishing."[4] A variety of pyrite commonly abounds in most alum-slates, in regard to which T. Scheerer[5] remarks: "Not only the marcasite, but also ordinary pyrite

[1] Cours Min. et Géol., A. de Selle, (1878), I, 472

[2] Traité Min., Dufrénoy, (1856), II, 540.

[3] Lectures on Min., T. Egleston, (1871), Pt. 11, 122.

[4] U. S. Geol. Survey, Geol. of Comstock Lode, pp. 882 and 231.

[5] Pogg. Ann., (1838), XLV, 188.

suffers decomposition through the action of air and moisture; although this occurs with the latter only under more favorable conditions. Pyrite, in compact rock and in large particles, resists almost all decomposition. If the same mineral, on the other hand, occurs in fine distribution, *e. g.*, in alum-slate, which, at the same time, on account of its loose texture, cannot reject infiltrating moisture, then the decomposition takes place most thoroughly and with proportionate rapidity." Ménes also,[1] after his examination of the massive pyritous deposits of France, concludes: "The yellow iron pyrites ...... occurs more particularly in the crystalline rocks and preserves itself very well in the air, while the white iron pyrites......is always found in sedimentary deposits and readily effloresces, with a formation of copperas." In the latter investigation by Girard and Morin,[2] of the French pyrites, they remark, in regard to the pyrite of Sain-Bel, which occurs in argillo silicious schists of Silurian age: "This is sulphide of iron almost chemically pure, and this purity prevails in almost all parts of the mass .....This pyrites is very slightly alterable; it only oxidizes with difficulty at ordinary temperatures."

This difference of stability may be readily verified in any mineralogical cabinet, by an examination of the comparative condition of the specimens of pyrite derived from the coal-measures, lignitic shales, and clays, etc., and those from the crystalline rocks of some highly metamorphic region, like Elba or Colorado. The former are invariably more or less crumbling and rusty, in spite of complete protection from ordinary weathering, within a building and even inside of tight glass cases; the latter remain hard and brilliant, even though they may have already been exposed to the weather for years, while lying in the waste upon the dump of some mine.

This sharp distinction between the varieties of pyrite is therefore unquestionable, as well as the existence of other forms which appear intermediate, in all degrees, in regard to resistance to natural oxidation.

[1] Compt. Rend., (1867), LXIV, 867.

[2] Ann. Ch. et Phys., (1876), 5 Sér., VIII, 229.

B.—EXPLANATIONS OF THE TENDENCY TO DECOMPOSITION.

Various theories will be now briefly considered, which have been advanced to account for this singular difference of stability, not only between ordinary marcasite and other pyrites, but also between the varieties of a single mineral of definite chemical composition, pyrite.

1. *Presence of some foreign impurity.* In one of the earliest discussions of the subject, J. F. Henkels remarks,[1] "it is a fact that the nodular pyrites vitriolesces more easily than the angular, likewise the radial than the laminated; I find also the causes in copper and arsenic, whereof the nodular, as also the radial, are wont to be free." With these two agencies, however, he also associates the texture of the mineral, with its accompanying density, and points out that one or more of these three conditions may be concerned in the difference of stability in one case or another, quoting the maxim, *unius rei plures possunt esse causæ.* Still later, Werner expressed the suspicion that the presence of arsenic, and Berzelius, that of manganese, etc., might be connected with the differences of decomposition in pyrites. The entire absence of these substances, however, from some of the most unstable specimens, and their occasional presence in pyrite of stable character, controvert this view. The instances are exceedingly rare in which such a connection has been established, *e. g.*, that of the pyrite of Cornwall, Penn., already referred to.

2. *Presence of free sulphur.* Stromeyer long ago suggested,[2] "It may perhaps be yet ascertained that pyrites may not be the true iron sulphide *in maximo,*" *i. e.*, with the formula, $Fe S^2$, "but a combination of the same with sulphur hydrate." The same view was adopted by others, but, it is sufficient to say it has not been confirmed by the most careful analysis.

3. *Inferior proportion of combined sulphur.* This view of Proust, to account for the more ready alteration of certain specimens of pyrites, is stated beyond in the words of Hatchett, but remains equally unsupported by later investigation.

[1] Pyritologia, Leipzig, (1754), 782-786.
[2] Gilb. Ann. d. Phys., (1814), XLVIII, 189.

4. *Feeble combination of the sulphur.* In a footnote on the paper of Berzelius, just referred to, the Editor, J. L. G. Meinecke, objects that arsenic, manganese, etc., do not occur in all the forms of white pyrite, and calls attention to its different mode of crystallization, steel gray color, ready decay, and also the fact that, "on rubbing it yields a strong sulphurous odor, whereby, as well as by its weathering, it reveals a less intimate combination with sulphur. From its ready decomposition and its free sulphurous odor, it is clearly deduced that the sulphur is not united to the iron in the same way as in pyrites." This reasoning also appears too indefinite and insufficient.

5. *Unstable condition of sulphur, through a little oxygen originally combined.* Among the earliest reported analyses of marcasite were those of Hatchett[1] in 1804, who advanced the following view, in explanation of the tendency of that mineral to decomposition, but one which remains unconfirmed by later analysis.

"The pyrites crystallized in regular figures, such as cubes and dodecaedrons, according to the above analyses contain less sulphur, and more iron, than the radiated pyrites, and perhaps than others which are not regularly crystallized. This difference, however, is not considerable: for the dodecaedral pyrites which afforded the smallest quantity of sulphur of any of the regularly crystallized pyrites, yielded 52.15; and the radiated pyrites, No. 5, gave 54.34; the difference, therefore, is only 2.19." "Mr. Proust is also of opinion, that the pyrites which contain the smallest quantity of sulphur are those which are most liable to vitriolization; and, on the contrary, that those which contain the largest proportion are the least affected by the air or weather. This opinion of the learned professor by no means accords with such observations as I have been able to make; for the cubic, dodecaedral, and other regularly crystallized pyrites are liable to oxidizement, so as to become what are called hepatic iron ores, but not to vitriolization; whilst the radiated pyrites (at least those of this country), are by much the most subject to the latter effect; and therefore, as the results of the preceding analyses show that the crystallized pyrites contain less sulphur than

[1] Phil. Trans., (1804), XCIV, 326 and 340.

the radiated pyrites, I might be induced to adopt the contrary opinion."

"But I am inclined to attribute the effect of vitriolization observed in some of the pyrites, not so much to the proportion, as to the state of the sulphur in the compound; for I much suspect, that a predisposition to vitriolization, in these pyrites, is produced by a small portion of oxygen being previously combined with a part, or with the general mass of the sulphur, at the time of the original formation of these substances, so that the state of the sulphur is tending to that of oxide, and thus the accession of a farther addition of oxygen becomes facilitated."

6. *Intermixture with pyrrhotite or iron protosulphide.* The attention of Berzelius was early called to these interesting phenomena of decomposition, and in a paper[1] on White Pyrites, he states: "if this pyrites is not regularly crystallized, it becomes covered with an efflorescence of vitriol, and is at last completely decomposed into it. This result is certainly to be attributed to a mixture of magnetic pyrites." However, even in the same paper he presents an analysis of such a crystal, in which the only variation from the normal constitution consisted in the presence of 0.70 per cent of manganese and 0.80 per cent of silica.

A few years later, he made experiments on the same subject, whose results are thus described:[2] "The white pyrite consists of two varieties, of which one, perfectly crystallized, remains unaltered in the air, while the other, which presents a confused crystallization, effloresces on exposure to the air and falls into a powder, evidently of the character of a vitriol. This phenomenon therefore proves a difference of composition between these varieties—a difference which is worthy of study in order to ascertain whether it is of a character which may explain the difference of both from yellow pyrite." Of the latter of the two varieties he allowed a fragment to effloresce 2½ years, and examined it after its complete disintegration.

"Its volume was nearly doubled; it was fissured in every direction, and fell to pieces at the slightest touch. A part of its

[1] Schweigg., Jour. Ch. Phys., (1819), XXVI, 67.

[2] Ann. Ch. et Phys., (1822), XIX, 440.

mass was converted into a white powder of styptic taste, and this powder began to become yellow at the extremities. Seen under the microscope, it presented a mass full of little cracks, filled with a white effloresced salt, in which the interstices appeared to consist of white pyrite, intact and more or less crystalline." A portion of this powder was digested in water, and the solution, separated from the insoluble residue, yielded, on addition of barium chloride, and then, after filtration, of ammonia to the filtrate :—

			Atomic	Ratio.
Barium sulphate 2.03 grams	Containing	Sulphur..0.279	.87	1
Ferric oxide....0.68 "		Iron 0.476	.85	1
		.755		

It was thus found that the solution contained neutral ferrous sulphate, $Fe\ S\ O^4 + 7\ aq$, equivalent in amount to 0.755 gram of iron protosulphide, Fe S. The residue insoluble in water, apparently undecomposed white pyrite, amounted to 4.653 grams, *i. e.*, over six times as much as the effloresced part. To determine whether it included any separated sulphur, a part of it was dissolved in nitro-hydrochloric acid, and analysed with the following results:

			Atomic	Ratio.
Barium sulphate......3.82	Containing	Sulphur.. .524	1.64	2
Ferric oxide 9.64		Iron ..... .448	.80	1

The insoluble part was thus found to consist of iron disulphide, $Fe\ S^2$. "Since therefore the effloresced part was a basic sulphate of protoxide which did not contain acid in excess, and since there were no traces of sulphur separated during the efflorescence, it is evident that the effloresced part has consisted of protosulphide of iron, which has not yet been found in an isolated condition in the mineral kingdom, and that the remainder, which was not subject to efflorescence, has consisted of the disulphide. The efflorescent pyrite cannot then be anything else but particles of deuto-sulphide, more or less well crystallized, cemented together by particles much less numerous of protosulphide, which are changed little by little, at the expense of

the air and of its moisture, into sulphate of iron ; the pyrite then loses its coherence in proportion as the cement of the crystallized particles is decomposed."

A little later, in 1828, Köhler stated in his paper[1] on the pyrites of Gross Allmerode in Hesse, that the ordinary nodular forms, consisting of marcasite (strahlkies), decompose readily, and break up, with an efflorescence of copperas, while the crystals themselves resist decay ; in the latter, the crystalline form is identical with that of pyrite, but the specific gravity is considerably lower. His words are : "A distinguishing property of this radiated pyrites is its mode of decomposition. The ordinarily very fibrous nodules possess the tendency, with an efflorescence of copperas, to break up entirely by degrees ; the crystals themselves resist the disintegration. The explanation is well known, which Berzelius gives of this phenomenon. Through chemical analyses, however, the undecomposed masses exhibit no differences of importance. Certain analytical results, obtained on different varieties of the Allmerode pyrite, have convinced me that it shows the same relative proportions as Binary Pyrite." In 1829, seven years after his first experiments, Berzelius adds:[2] "When a portion of common pyrites was permitted to fall asunder, I found it to be caused by the formation of a small quantity of protosulphate of iron, which burst asunder the crystallized mass. When the salt was dissolved in water, no trace of free sulphur was obtained, from which it appeared that the efflorescing pyrites contains particles of $\dot{F}e\,S$ (sulphuret of iron), which, changing to the state of salt, tears asunder the rest which undergoes no change .. I have since obtained a satisfactory proof of the accuracy of this explanation. I heated carbonate of iron gently in a stream of sulphuretted hydrogen. There were formed, first sulphuret, and afterwards bi-sulphuret of iron. The experiment being stopped before all the iron was changed into bi-sulphuret, a pyrite was obtained, which, in a few days, fell asunder in all directions, and changed into a woolly mass of vitriol of ten times its former volume. Sesqui-sulphuret of iron prepared from the oxide has not this

[1] Pogg. Ann., (1828), XIV, 96.

[2] Berzel. Arsberät, (1829), 129.

property. It seems therefore highly probable that the falling asunder of the common pyrites arises from the electro-chemical action of the electro-negative bi-sulphuret which is here and there mixed with it in small particles." On comparing the figures quoted above, in the original experiment of Berzelius, I find by calculation that, according to his view, the mineral under trial must have consisted of:

	Per Cent.				Atomic Ratio.	
$Fe S^2$	86.04	Equivalent to	Fe	49.04	.876	11
Fe S	13.96		S	50.96	1.593	20

This is a relationship, however, which has never been reported in the analysis of marcasite by Berzelius himself or any other analyst, and is virtually contradicted by the results of Köhler, already cited, and others, who have always obtained the ratio 1 : 2. To account therefore for the apparent loss in Berzelius' analysis, we must infer either the presence of a part of the ferric sulphate in the residue insoluble in water, or a remnant of impurity, perhaps a salt of baryta, in the precipitate of ferric oxide, or, more probably, the previous escape of a part of the sulphur from the decomposing mineral or from the free sulphuric acid in the vitriol, in some form, it may be as hydrogen sulphide. This gas might readily be generated through the deoxidation of sulphuric acid by the organic matter in the dust, introduced during the long exposure of two years and a half. A further reference to this widely prevalent view is made in connection with the chemical investigation described beyond.

7. *Enclosure of clay in pyrites.* Still another and more recent view, worthy of consideration, is that of Messrs. A. Girard and H. Morin,[1] in their discussion of the pyrites of the French deposits of commercial importance for the manufacture of sulphuric acid. These writers discriminate between three pyritous varieties:

a. Grayish yellow octahedral pyrite, of sp. gr. = 5, occurring particularly in the volcanic formations and crystalline rocks;

[1] Ann. Ch. et Phys., (1876), Sér., 5, VII, 229.

its deposits always suggest igneous action, present the appearance of veins, contain no water, and are stable on exposure to the atmosphere.

b. Gray cubical pyrite, with brownish-black powder, containing both clay and water, commonly occurring in sedimentary deposits, and easily altered to ferric sulphate.

c. White marcasite, gray to yellow or greenish-yellow color; lighter than pyrite, with dark greenish-gray powder, and sp. gr. =4.7. Its masses are connected always with aqueous action, occur in deposits caused by chemical double decomposition, and are extremely subject to efflorescence of copperas. In explanation of these differences in weathering, it is stated: "We must yet remark that, in the specimens of yellow pyrite, water of combination or moisture is almost never found, as in the white pyrites. Some authors think that the facility with which these pyrites generally effloresce in the air is connected with the fact that these minerals contain protosulphide of iron. That may be; but I think that it can be also admitted (after my present analyses) that the molecular state of the substance, or, still more, the enclosure of a clay, easily attacked either by atmospheric agents or by water, may well be a ready cause of their alteration; and by this very fact it is natural to conceive, that sedimentary or chemical deposits (in the interior of formations) ought to readily assume this kind of constitution, which would be, so much the more, a common element of their spontaneous destruction." On this suggestion of the influence of clay, it must be noted that the material used in all the painstaking researches of these analysts was unsuitable for the solution of the delicate problem involved in the peculiar decomposition of marcasite. Their analyses appear to have been made, not on pure crystals, so far as stated, but on nodules or massive and granular forms of the two minerals. In all, the amount of silica, etc., reaches 4 to 15 per cent.; the specific gravity figures are correspondingly very low, 4.17 to 4.81; and the amount of water appears to have but partial connection with that of clay, since the proportion of alumina is small.

8. *Uneven condition of the surface.* Like nearly all the later authors who have written on the subject, since the time of Ber-

zelius, Senft accepted the hypothesis of that investigator as to the presence and influence of iron protosulphide. However, the absence of definite proof of its occurrence in marcasite inclined him to suggest an additional reason for its ready alteration, viz., the morphological character of the surfaces of its crystals. The evenness of those of pyrite, he maintains,[1] must offer far fewer points of attack to the agents of decomposition, air and moisture. However, the observations presented at the close of this paper (*e. g.*, in regard to the octahedra of pyrite at Weehawken, etc.), indicate rather that the varieties of this mineral with highly polished evenly faced crystals are peculiarly liable to decomposition ; while those at other localities, which are strongly striated, appear to possess a crystalline constitution which presents unusual resistance to decay.

9. *Forced state of aggregation of particles.* Fournet[2] presents the following explanation of the efflorescing property of white iron pyrites. "I have sought in the course of this memoir to establish two principal facts, to wit ; that a spontaneous tendency to dimorphism produces the disintegration of minerals, and that this is followed by chemical action ... Pyrites have two forms, the one cubic, the other prismatic ; may not the latter be simply an unstable form ? because, as it is well known, it is very liable to efflorescence, while the former resists decomposition pretty generally, under similar conditions. Carbonate of lime crystallizes in two systems, the one rhomboidal, the other prismatic. The latter, which constitutes aragonite, is so unstable that it is sufficient to warm a crystal a little to have it fall to powder ; and besides, in Auvergne, masses are found which spontaneously disintegrate without further decomposition."

10. *Some peculiarity of molecular aggregation.* To a cause of this kind, though entirely undefined, several authors have been inclined to attribute the perishability of ordinary forms of marcasite. Thus, in 1849, Nicol[3] remarked : "This mineral is still

[1] Kryst. Felsg., 141.

[2] Ann. Ch. et Phys., (1834), LV, 255-256.

[3] Mineralogy, (1849), 451.

more liable to decomposition than pyrite, though in the same manner, and most frequently changes to sulphate of iron. In both minerals this has been ascribed to a mixture of Fe S ; but the above analyses all show a surplus of sulphur, which, though small, would rather indicate a mixture of free sulphur as the cause. It, however, has been observed in pure sulphuret of iron, and seems rather to depend on some peculiarity in the state of aggregation." More recently a similar view has been expressed by J. P. Kimball,[1] to explain the difference in stability of the two minerals. "At ordinary temperatures, under exposure to the atmosphere, bi-sulphide of iron in the form of white pyrites or marcasite readily decomposes, but far more slowly when in the form of yellow pyrites or pyrite. Such a difference as to facility of oxidation appears to be due to molecular differences arising from crystalline structure. Marcasite occurs in several states of crystallization and aggregation favorable to oxidizing influences, as compared with the usually more compact mode of occurrence of pyrite. It is in the more readily decomposable form of marcasite that bi-sulphide of iron generally occurs in bituminous coals and lignite, while in anthracite it is generally, if not always, present in the form of its more stable species." It is evidently in this direction that we must search for the exact solution of the problem.

C. Chemical Analysis of Pyrites.

On account of the doubt still prevailing in regard to the commonly accepted cause of the tendency to decomposition, *viz.*, the possible presence of iron protosulphide in decomposing pyrites, there seemed to me to be evident need of additional chemical analyses, made with the utmost care possible with modern facilities, on crystals selected for probable purity ; in these I have availed myself of the assistance of Dr. J. B. Mackintosh. For this purpose, the finely crystallized spear-headed marcasite, from the ashy gray chalk of Folkestone, England, was first chosen, this matrix being unlikely to supply other metallic bases or arsenic as impurities in the mineral. The following mode of analysis was adopted. A carefully weighed amount of

[1] Trans. Am. Inst. Min. Eng., (1879–80), VIII, 202 and 215–216.

the mineral, about 3 grams, was placed in a glass-stoppered bottle, with the addition of nitro hydrochloric acid and bromine, inserted in a beaker of water, and covered by a smaller inverted beaker, to make a water-joint for safety, and thus digested upon a water-bath until complete solution. This was then diluted and divided. In one part, the iron was determined volumetrically in the usual way, by means of potassium permanganate. To the other, citric acid was first added to retain the iron in solution and the sulphuric acid was precipitated by a slight excess of barium chloride. After thorough washing, this precipitate was purified by Stolba's method, by digestion in copper acetate, washed and weighed, then fused with mixture of sodium-and potassium-carbonates, leached out with water, the other solution treated with bromine, the residue and filtrate separately acidified, the two solutions heated on the water-bath and combined, and the re-precipitated barium sulphate again thoroughly washed, dried and weighed. In all cases the first precipitate was found before the fusion to contain a small proportion of barium-salt as impurity, and in one case a coloration produced by copper derived from the copper acetate. Of the analyses presented below, Nos. 1 and 2 were made upon the finely pulverized mineral, No. 1 having been weighed immediately after pulverization, and No. 2 about three-quarters of an hour afterwards. In both, it will be noticed that the amount of sulphur is considerably less than that demanded by the theoretical constitution of the mineral, especially in No. 2, whose material was longest exposed to the air. A series of a dozen samples of pyrite and marcasite, in finely divided condition, had been already exposed to the air, and it was found that these manifested incipient decomposition in all cases, often within one or two hours, by a caking of the powder and a distinct sulphurous odor. A portion of the Folkestone marcasite, about 0.2 gram, was also enclosed with 2 c. c. of concentrated hydrochloric acid, in a hermetically sealed tube; the mineral had been, previously exposed to the air for several hours, in the state of a fine powder. In another tube, a freshly broken pure lump of the mineral was digested in the same way. The former immediately yielded a yellowish solution, revealing the presence of iron-oxide from partial oxidation of the exposed powder; however, on hanging a few days in the sunlight, the solution gradually lost its color, appar-

ently from a subsequent deoxidation of the ferric chloride in the presence of the iron disulphide. The tube was hung up by a south window and remained at the temperature of the laboratory for ninety days; then, on opening by breaking under water, not a trace of either iron or sulphur was detected in the colorless fluid. The other tube, containing the lump, remained colorless, even after several weeks. These experiments proved that the variety, though stable, became unstable in fine powder, and that it was impossible to obtain sufficiently accurate results from analyses of the marcasite in the finely divided condition. This was probably caused by the condensation of oxygen upon the enormously increased surface, the addition of its weight and its partial combination with the iron and sulphur. The experiments also proved the absence of any trace of iron protosulphide, of oxygen, or of other soluble impurities, which have been suggested by some investigators. On the ground of these experiments, the method of quantitative analysis was therefore again modified by taking a rapidly weighed lump of the mineral, in the analysis whose results are headed No. 3. The process of solution was of course considerably slower than in the case of the fine powder.

Analysis of crystalline marcasite from Folkestone, Eng. Sp. Gr. = 4.887.

	1 Fine powder.	2 Fine powder.	3 Lump.	Theoretical Constitution.
Iron	47.310	46 807	46.705	46.667
Sulphur	52.780	52.464	53.359	53.333
	100.090	99.271	100.064	100.000

A qualitative analysis of the mineral also showed the absence of other metallic bases and of arsenic. The close approximation of the last analysis (No. 3) to the theoretical composition is of course partially accidental, as every chemist will understand, but justifies the conclusion that the marcasite of Folkestone contains no iron protosulphide. The surfaces of some of the crystals in its groups are encrusted by a film or coating of orange-colored iron-ochre, which indicates its liability to slow

oxidation, but they never display an efflorescence of iron sulphate. The next material, selected for analysis, was the fibrous white and brilliant pyrite, associated with galenite and blende, at Marsden's Diggings, near Galena, Illinois, and partially discolored by an efflorescence of iron sulphate. A lump, freed from the efflorescence and weighing about 3 grams, was dissolved in the usual way, and the following results obtained.

Analysis of fibrous pyrite, from Marsden's Diggings, Ill. Sp. Gr. = 5.015.

	Per Cent.		*Theoretical Constitution.*
Iron	46.636		46.667
Lead	.188		
Silica	.110		
Arsenic	.056		
Sulphur	52.739[1]	53.010	53.333
Loss	.271		
	100.		100.

An absolutely exact determination of sulphur is impossible by any known gravimetric method; this is partly caused by the decomposition of a small part of the precipitate obtained of barium sulphate adhering to the filter, by the deoxidizing action of the carbon, on ignition of the paper. In determinations of this kind, a similar loss almost invariably occurs, amounting to over one per cent. of the total quantity of sulphur, the ignited precipitate being apt to assume a yellow color, it may be from the formation of barium peroxide. It therefore seems fair to presume that the loss in the above analysis consists chiefly of sulphur. The figures thus imply a close correspondence to those demanded by theory, if the material was pure. The slight impurity, indicated by traces of lead and arsenic, is merely that which might be expected in a mineral which is constantly associated with galenite in the locality stated. We may therefore conclude that decomposing pyrite contains no proportion of iron proto-sulphide, and that the cause of the decomposition must be sought in some other direction. The analyses of both these minerals therefore, marcasite and pyrite, prove that difference

[1] 53 617, before purification of the precipitate of barium sulphate.

of chemical composition has nothing to do with the differing quickness of tendency to decomposition, but also hint the possibility of its connection with some subtle peculiarity of structure.

D.—MICROSCOPICAL EXAMINATION OF PYRITES.

In order to throw more light on this difficult question, I have resorted to a microscopical examination of several kinds of pyrites. The only microscopical examination on record, to my knowledge, is that by Berzelius, on an efflorescent marcasite; he simply states that, "seen under the microscope, it presented a mass seamed by little cracks, filled with a white and efflorescent salt, whose interstices appeared to consist of white pyrite, unattacked and more or less crystalline"; also, on dissolving out the efflorescent salt, he could detect no sulphur in the residue.

Pyrite from Galena, Ill. I selected, as a material most promising of results, a portion of the same nodule of pyrite in a state of decomposition, which had been used in the chemical analysis just mentioned. The conical specimen consisted of a finely fibrous material, with fibres about eight centimeters in length, and mostly 0.2 millimeter in thickness, radiating from the apex of the cone, the center of the original nodule, becoming coarser toward their outward extremities, and there terminating in a close aggregation of distorted cubes, 4 to 8 mm. on a side. The inner material was of a pale yellowish-white color and exceedingly brilliant lustre, crossed by three or four concentric lines of concretionary growth; an easy cross-fracture occurred at the concentric lines, leaving a surface—across the ends of the fibres—which appeared to the eye perfectly aphanitic in texture, exceedingly brilliant, and slightly mammillary. At the outer surface, the aggregated cubes were stained to a brownish-black, variegated by delicate whitish efflorescence within the interstices; this efflorescence was found to penetrate to a depth of about 1 to 2 centimeters below the surface, along the fibres, and even to the very centre of the nodule, at a depth of 8 centimeters, along certain widened fissures among the fibres. The material differed little from that of similar fibrous nodules from Galena, Ill., Linden, Wis., etc, whose specific gravities are presented in the table near the close of this paper. Various fragments of this material were mounted for examination by reflected light; and for

this purpose low magnifying powers, up to 200 diameters, were found sufficient, with the help of the plane mirror of a Sorby reflector. The following materials were thus examined.

a. A fibrous plate of the fresh and brilliant material from the interior. The surface of this natural fragment was divided up by the fibration, by strongly marked lines, sometimes perhaps indicating open fissures, 0.033 to 0.134 mm. apart. Within these in many places a still finer lineation occurred, the lines being sometimes only 0.014 mm. apart. These finer lines, coinciding with the cubic cleavage, were sometimes parallel to the main fibration, sometimes perpendicular to it; elsewhere, very commonly arranged obliquely at an angle of 45° to 53° from the general direction, sometimes even in two sets passing obliquely off in opposite directions from a median line. These latter oblique lines doubtless mark the octahedral cleavage of pyrite, often greatly distorted by pressure and even thereby rendered curvilinear. A want of homogeneity was suggested by a number of bright angular yellow particles and grains, scattered over the white and duller surface: their size usually varied from 0.013 to 0.084 mm.

b. A fragment, from a plane at right angles to that of *a*, presenting the polished mammillary and curved surface from the cross-fracture. The entire surface was found to be, not uniform as it appeared to the eye, but seamed and slightly roughened by short fissures, marking the cubic cleavage, running at right angles to each other, but rarely intersecting, and dividing up the surface into square spaces about 0.01 to 0.015 mm. on a side. The same bright yellow grains appeared here and there, as in *a*, but mostly as lines or thin branching veins, apparently the edges of films of yellow material enclosed in the paler colored pyrite.

c. A portion of the side of a fissure, plainly to the eye darkened and roughened by incipient decomposition, but still apparently perfectly dense and compact, showed under the microscope a remarkable sub-division and disintegration, the whole surface being seamed by minute cracks, mostly along and across the fibres, and also irregularly pitted and even honeycombed with cavities of the most irregular shape and size: all this surface was sprinkled and coated with granules and needles of the white efflorescence. The phenomena differed widely on every

surface examined, but mostly comprised the following points of structure in the pyrite itself :

First. A coarse columnar structure, that of the fibration, presenting a width of about 0.08 to 0.25 mm. between the parallel fissures, whose lips were about 0.005 mm. apart. This was crossed, with more or less irregularity, by fissures at right angles, often producing the effect of an imperfect tesselated pavement or of rude masonry. In places the disintegration had gone so far that the mass consisted of dark roughened needles attached only at one end or both.

Secondly. The surface intervening between these cracks was pitted with cavities of the utmost irregularity of size and form, though commonly approximating 0.004 to 0.009 mm. in diameter, scattered in rows and in large groups. As a result of the sub-division produced by these cracks and pits, I estimated that the greater part of the mass was separated into little grains, approximately cubical in form and about 0.01 mm on a side. It would require about a thousand millions of such little grains to make up a cubic centimeter of the material, and the surfaces of these would present a superficial area about ten million times that of the superficies of a solid cubic centimeter.

Thirdly. The surface between the little pits further showed a very delicate striation, apparently by fine cracks or by minute ribs and furrows, all parallel to the line of fibration but slightly wavy. On an average about 555 of such lines occupied the distance of one millimeter across the fibration, *i. e.*, they were about 0.0018 mm. apart. They projected very slightly above the intervening furrows and conveyed the impression that they were lines of accretion, running in the direction of the general fibration and originally producing that structure ; that they represented the edges of thin films of a compact material, flattened out by intense lateral pressure, whose irregularity had produced the wavy disturbance of their lines ; also that their material was harder and perhaps brighter than that in the intervening furrows, and that their projection above the surface was but a part of the general erosion, caused by their greater resistance to decomposition than that offered by the intervening films.

Fourthly. The suspicion of the want of homogeneity of the material was fostered by the occasional distribution, over the

dull eroded surface, of minute bright grains, scales, pellicles, and angular, sometimes branching, rods, contrasting with the general surface by their brilliant lustre, yellow color, and sometimes a slight projection. Many consisted of barely visible particles and lines, but the size of 0.005 to 0.035 mm. was sometimes noticed.

Occasionally triangular and rectangular outlines could be distinguished, even 0.056 mm. in length, and rarely two or three faces of a flattened polished cube. Their 'compact bright material appeared identical with that of the striation films, and in fact, many of these forms appeared mere expansions or projections of these films. All the facts strengthened the idea that the material of this fibrous pyrite is not uniform, as it appears to the eye, but that these grains and minute lines indicate the planes of successive envelopment of two materials, the one yielding rapidly to decomposition, the other more dense and yielding more slowly. The little pits or cavities were also closely examined to determine whether they ever presented symmetrical outlines, which might signify the eating away of crystals of a softer substance, but no such indications were recognized.

Fifthly. The white efflorescence rarely displayed any distinct forms, except those of occasional needles with imperfect terminations. The entire absence of any yellow or reddish tinge indicated that it consisted of a basic ferric sulphate, and this was confirmed by the blue reaction produced by potassium ferridcyanide in a solution of the effloresced salt. However, when fragments on a slide, immersed in a drop of potassium ferrocyanide, were examined under the microscope, traces of a blue coloration were also seen, which showed the presence of copperas, ferrous sulphate, in minute amount. It would not be possible, without the most careful analysis, to determine the exact character of such a natural vitriol; since it may be constituted, according to the degree of oxidation and hydration, of indefinite mixtures of at least eleven known salts, viz., one ferrous sulphate, eight ferric sulphates, and two ferroso-ferric sulphates.

d. The darkened surface of a cube from the outer surface, slightly marked to the eye by minute particles of the vitriol-efflorescence. This presented, under the microscope, a finely

granular mass of the pyrite-material, seamed and interspersed with the white particles, grains, and sometimes needles of copperas in an almost continuous network. The surface was generally deeply and very irregularly eaten out and honeycombed in pits and cavities divided by jagged angular septa; these cavities often possessed a diameter of 0.06 to 0.10 mm., with a depth of about the same amount. Many of the grains of pyrite displayed cubical outlines, about 0.025 mm. on a side, which indicated the full development of the cubical cleavage. On similar corroded and effloresced surfaces, on the side of fissures further down, below the point where the cubes were developed, the eroded pits were a little larger, about 0.167 mm. in diameter, but the grains of pyrite did not exhibit cubical forms.

Pyrite, from Chili. The polished surface of a cube, about 1 centimeter on a side. To the eye, this surface showed a distinct striation in places; under the microscope, little more than planes of accretion, parallel to the edges of the cube, became visible. The material appeared almost perfectly uniform and homogeneous.

Pyrite, from Weehawken, N. J. The surfaces of octahedra, in various stages of incipient oxidation. A surface which was brilliant and polished to the eye appeared almost equally so under the microscope, and the underlying material, shown on conchoidal fractures along the edges, seemed to be homogeneous, though very pale in color. But many other surfaces, showing a tarnish to the eye, presented in high illumination, under the microscope, a brilliant display of iridescence, resembling that of marcasite. Very often this tarnish was not uniformly distributed, but displayed alternating bands of blue and red colors, parallel, or intersecting each other in two or three directions, parallel to the edges of the octahedral faces. This mode of decomposition implies probably a uniform distribution of an enclosed unstable impurity; since the course of the oxidation has conformed exactly to the cleavage structure of the crystal. Other octahedra from the same locality showed the last stage of complete oxidation, in the form of limonitic pseudomorphs, preserving, almost perfectly, the lustre of the faces and sharpness of the edges and minute modifications. In places, delicate reddish-brown crusts were found deposited upon some

of the crystal-faces. The fractured edges of these exhibited alternating brown and white lines, evidently the edges of alternating films of red iron-oxide and of white gypsum. On other octahedra of pyrite, less deeply attacked by oxidation, the reddish brown coating, about 0.1 mm. in depth, was observed to be sprinkled with little particles and short needles of white vitriol. Their identity was sufficiently established by putting such a crystal in a drop of water on a slide, with a drop of potassium ferrocyanide in close juxtaposition, and connecting the two drops by means of a wire, while under observation, when the blue precipitate was formed which indicated the presence of a soluble iron-salt. The observation was one of interest, in suggesting that the slow oxidation, which results in the formation of a crust of iron-oxide, differs in no way from that which produces the efflorescence of white copperas, in other materials, except in the further complete oxidation of the iron protoxide. It may also be again suggested that the presence of organic matter, as dust or in solution, must result in the final deoxidation of the sulphuric acid set free in this decomposition, with its escape as hydrogen sulphide, or sometimes a partial deposit in the form of free sulphur.

Pyrite, from Lee, Mass. Thin flakes of the white dolomitic marble from Lee, containing pyritous particles in an active state of decay. These were chipped from the surface of fragments thrown aside from the construction of the Cathedral at Madison Avenue and Fiftieth Street in New York City, which had been lying exposed to the weather for a few months. Each rusty particle was surrounded by a reddish-brown ochreous film, penetrating the marble irregularly in every direction, sometimes to a distance of one or two centimeters from the decaying particle. The instability and consequent discoloration were so marked, as to suggest the possibility that these particles might consist of marcasite. To determine their true nature, five pounds of the stone were dissolved in weak hydrochloric acid, and the insoluble residue was found to consist of angular grains of white quartz, scales of red and colorless phlogopite, and the pyrites, with a small quantity of imperfect prisms of brown and black tourmaline, white tremolite in acicular granules, and bent rods of black rutile. The pyritous grains presented ordinary forms

of the modification of cubes of pale brass-yellow color and brilliant lustre, certainly consisting of crystallized pyrite. No visible reason for the decay was apparent in these crystals.

From these microscopical observations, presented elsewhere[1] in fuller detail, we may sum up the following conclusions :

First. In these fibrous nodules of pyrites, the outward growth of the elongated cubes, of which the fibres consist, and their mutual compression, have produced a condition of great tension, which has facilitated their later disintegration.

Secondly. The material is mainly composed of a diluted mixture of pyrite with a paler colored and unstable impurity. Through this mixture, more or less pure pyrite is diffused in alternating films or in scattered strings and crystals of a deeper yellow color than that of their matrix.

Thirdly. The oxidation of the material has been facilitated by its heterogeneous composition, by its fissured structure, and by the tension among its fibres. It has progressed more rapidly in the predominant paler colored mixture, has penetrated along the seams between the fibres, and has then been hastened by the development of the more minute fissuring, as the result of the tension.

Fourthly. The development of this system of minute fissures has furnished an enormous area for the internal condensation of gases and vapors from the atmosphere, chiefly oxygen and moisture, which has resulted in the speedy oxidation, pitting, decay, production of crystals of vitriol, expansion, and final disintegration observed in such forms of pyrites.

Fifthly. The mode of oxidation in all forms of pyrite is essentially the same, resulting in the initial production of ferrous sulphate and free sulphuric acid. By the removal, decomposition, or neutralization of the latter, oxidation of the ferrous salt is promoted, which may be then rapidly converted into one or more ferric sulphates, when freely exposed to the air. In the purer forms of pyrite, subject to but slow oxidation, the results of decomposition are washed away as fast as they form, and the surface of the mineral retains its brightness, if the grain lies ex-

[1] The Microscopical Structure of the Iron Pyrites, Jour. N. Y. Micr. Soc., (1886), 1–12.

posed to the air on the surface of a stone ; if buried beneath the surface, the ferrous sulphate is likely to be immediately converted into a comparatively insoluble ferric-sulphate, and from that the ferric oxide may be immediately deposited ; if the matrix is calcareous or magnesian, the ferric oxide is deposited at once in place by precipitation, and a hepatic pseudomorph finally results. This material may consequently detain small quantities of lime and magnesia within its pores. Prof. Erastus G. Smith has reported[1] these traces in his careful analysis of such a limonite-cube, from the Trenton limestone near Beloit, Wis.

In the impure forms of pyrite, inclining to rapid oxidation, the soluble ferrous sulphate is transported farther away, through the matrix, before further oxidation and precipitation take place. The extent of the discoloration thereby produced is limited only by protection from air and moisture ; the formation of hepatic pseudomorphs is accomplished only in the presence of an excess of basic precipitant, such as "rock sap" saturated by calcium-carbonate.[2]

E. General Conclusions in Regard to Variation in Decomposition.

A consideration of the facts connected with the paragenesis of the three iron pyrites, especially of the general intermixtures, intercrystallizations, and mutual replacements of the two more common species, marcasite and pyrite, leads to the conclusion of the constancy of their association in the most intimate forms. Wherever the least deviation is noticed from the ordinary physical properties of either mineral, the presence of the other may be at once suspected. The opacity of both preventing the application of most optical tests, resort must be had to the close examination of other physical properties. We are thus led to the following general conclusions :

First. In regard to marcasite, the tendency to decomposition and its absence are plainly associated with other physical properties. When the mineral occurs in the rarer condition of compact well formed crystals, with brilliant lustre, grayish-white

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[1] Am. J. Sci., (1886), XXXI, 376.

[2] During publication, I have found this theory already suggested in a brief note to *Pyrite*, in Dana's System of Mineralogy, (1883), 64.

color, and high specific gravity, it resists decomposition as effectively as the stable form of pyrite and as most silicates. But when it occurs in crystals with lower lustre and density, whose color inclines to a greenish tint, or in finely granular, scaly, or columnar masses, of lower lustre, density, and purity of color, and in which a little clay and moisture can be detected by analysis, such varieties are certainly inclined to more or less rapid decomposition by efflorescence.

Secondly. The two minerals, marcasite and pyrite, are very commonly and abundantly associated (*a*) in more or less thoroughly intermixed masses, in which the grains or plates of each may often be yet distinguished—(*b*) in nodules consisting of successive enveloping crusts, composed alternately of each mineral, or of mixtures of both—and (*c*) in crystals consisting of the substance of one mineral, assuming the form characteristic of the other. In most cases the constituents of such mixtures and associations may be distinguished by their general physical properties: marcasite, for example, by its color, generally lower specific gravity, somewhat inferior hardness, uneven fracture, and usual strong tendency to decomposition.

Thirdly. The crystals and nodules which are generally assigned to pyrite, on account of the crystalline forms of that mineral (cubes, octahedrons, etc.), which the individual grains present, seldom consist certainly of that mineral in a pure condition, save when they also exhibit its characteristic brass-yellow color, high density and lustre, conchoidal fracture, and strong resistance to decomposition. When inclined to alteration, however, they invariably exhibit either a paler yellow, whitish or greenish color, a low density and lustre, uneven fracture, and tendency to granular or fibrous texture.

Correlating then these three facts, the peculiar physical properties of marcasite, its common intermixture with pyrite, and the presence of its other physical properties in most of the varieties of pyrite which show ready alteration, the following conclusion seems inevitable. *All specimens of pyrite in active decomposition are not pure, but are intimate intermixtures of marcasite and pyrite, probably in the most minute, i. e., molecular conditions of these minerals.*

We may here recall the interesting investigation of G. Brügel-

mann on the variation of specific gravity, and of other physical characteristics in series of artificial intermixtures, in various proportions, of simultaneously crystallized salts. His observation, that "crystalline intermixtures have for the most part a different specific gravity than that which corresponds to the calculated mixture-proportions of their components,"[1] was referred to changes of volume, whose course, like that of the figures for specific gravity, ran without any parallelism to that of the changes in mixture-proportion. This conclusion, however, can have no pertinency here, as his salt-intermixtures were all obtained by fusion, usually accompanied by expansion. Those now under consideration—the natural intermixtures of the two dimorphous sulphides—are certainly deposits from solution, and, however intimately blended, may be far from homogeneous and have probably never been attended with any change of volume.

There is every reason to believe, that, in the lessened sensibility toward chemical action exhibited by the harder and heavier of these two homologous minerals, we have a fresh illustration of the well-known law, which, in another connection, T. Sterry Hunt has thus stated: "The hardness of these isomeric or allotropic species, and their indifference to chemical reagents, increase with their condensation, or, in other words, vary inversely as their empirical equivalent volumes."[2] The fact of the inferior hardness of marcasite, though not recognized in the general treatises on systematic mineralogy, has already been noted in the papers of Breithaupt, Senft and others; I have pointed out beyond that it specially characterizes certain crystallographic faces of that mineral. It may be safest to refer the mode of condensation of the molecule in the heavier mineral, pyrite, to subtle schemes of natural blending or interpenetration, of course far beyond microscopical detection, and, it may be, passing all present comprehension. But taking into consideration the physical properties which can be recognized, we are led to suspect that the material of the lighter crystals of marcasite, and especially of its granular forms, may consist in miniature of an interlacing network of the

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[1] Ueber die Krystallisation, Beobachtungen und Folgerungen, Leipzig, (1884). 17.

[2] Chem. and Geol. Essays, 457.

spearheaded crystals, needles, twins, etc., which the natural forms of this mineral present to the naked eye. Within these interstices, air and atmospheric moisture are condensed over the entire area and locked up in the most constant and intimate contact; or these invisible cavities may be partially occupied by other sulphides, clay, quartz, etc., whose presence is shown by chemical analysis. Both the area exposed to attack and its duration must enormously exceed those possible on the ordinary exterior surface of a visible crystal; while color, lustre, and density are equally decreased by the porous texture of the mass. If we can assume such a molecular constitution, the well-known facility of decomposition will be easily understood. On the other hand, the associated high specific gravity and resistance to decomposition shown by the well crystallized forms of the mineral, such as those from the chalk, are well explained by the corresponding compactness of texture and absence of interstices, attending the metasomatic alteration or replacement of the mineral by pyrite.

With pyrite, on the other hand, we may perhaps assume a naturally compact texture, when pure, from the crystallographic symmetry of forces implied in its isometric constitution. The resulting absence of interstitial cavities and impurities, and therefore of an internal area exposed to condensation of oxygen and consequent decomposition, are naturally accompanied by the high color, lustre, density, and freedom from alteration observed in well crystallized forms of the mineral. But the general deterioration of the common varieties of the mineral in all these properties, and their close approach to those of marcasite, appear to imply a general intermixture with that mineral, except in regions of high local metamorphism, such as Elba, Colorado, etc. In the fibrous, and especially in the granular forms of pyrite, such as constitute the usual nodular and radiating forms of the mineral, the intermixture of marcasite becomes at last visible, at least under the microscope, and these forms are notorious for ready decomposition. But the absorption of oxygen, shown in the preceding analyses, indicates that it may also be true that even pure pyrite, in so finely divided a condition, may yield far more easily to oxidation. The early observer, Henkels,[1] recognized the fact that the rapidity of vit-

[1] Pyritologia, Leipzig, (1754), 805 and 790.

riolescence was increased in pulverized pyrites, attributing it to the increase of exposed surface; also, that in nodules, this action begins in the interior, where the texture is loosely granular and full of clefts. So also Knop[1] found, on direct experiment on the pyrrhotite of Horbach, "that the vitriolescence of the ore in a finely divided condition proceeds more rapidly than in the form of larger fragments." In the fibrous nodules of pyrite, the material appears to be also in a state of extreme lateral tension, which has facilitated its thorough sub-division by fissures, the deep entrance of air and moisture, its rapid oxidation, and ready and continual yielding to further disruption by the outward pressure of the copperas crystals formed during efflorescence. In the preceding discussion attention has been entirely given to the common varieties of pure iron-pyrites, without regard to the exceptional cases, only one of which is on record, in which other metallic sulphides, *e. g.*, chalcopyrite, have acted as as accessory agents in producing the tendency to decomposition. Other instances will be given beyond.

II.—Determination of Degree of Stability.

There are many practical applications of these facts, stated at the close of this paper, which show the pressing need of artificial methods of experiment, by which to determine the inclination to oxidation or degree of stability in certain specimens of these iron sulphides. We may, in passing, here refer to the experiments of Malaguti and J. Durocher,[2] who tested a series of specimens of metallic sulphides with a solution containing silver chloride, and then determined the amount of the silver salt thus decomposed. From their general results we may select the following, which, in the third column, represent the comparative action of the iron sulphides on the silver salt, the amount of the sulphides being taken as 100.

[1] N. Jahrb Min. Geol. Pal, (1873), 521.
[2] Ann. d. Mines, (1850), 4 Sér., XVII, 294.

	Sp. Gr.	*Amount of action.*
Yellow cubical pyrite, containing no visible impurities, - - -	4.402	0.25
Yellow pyrite, in icosahedrons, Kongsberg,	4.601	.50
Compact marcasite, (Fe, 44.6 per cent.),	4.931	.50
Yellow pyrite, in pyritohedrons, -	4.973	1.00
Radiated and globular marcasite, "pyrite blanche," (Fe, 45.4 per cent.), -	4.771	1.00
Marcasite in advanced decomposition,		1.00

In reference to these results, the authors remark: "Thus in the series of the iron pyrites, which are generally quite pure, it appears that the facility of decomposition varies with the densities and the crystalline forms; in a word, with the molecular condition." However, but slight analogy can probably be assumed between the results of the action of a silver solution upon pyrites and those of the weathering now under consideration. The proper experimental methods for our purpose may be either chemical or physical; the one, by exposure of the specimen of pyrites to the action of an oxidizing atmosphere or liquid; the other, by determination of the specific gravity of the specimen under trial.

A.—TRIAL OF PYRITES BY OXIDATION.

Several methods of trial were tested, some with the object of quantitative estimation of the products of oxidation. Only brief reference need be made to methods found unsatisfactory.

I. *Trial of powder in bromine-vapor.* In the following table are presented the results of experimental trial of a series of typical forms of pyrite from a number of well-known localities, arranged very nearly in the order of decreasing specific gravities. The specimens were finely powdered, and passed through bolting cloth, and exactly one gramme of each was spread out thinly over a shallow watch-glass. These were all exposed, under a large bell-glass, to an atmosphere of bromine-vapor, for the same length of time, twelve hours; the iron-oxide set free was then dissolved out in sulphuric acid, and its amount determined volumetrically. The results obtained, in the fourth column, show the correspondence of decreasing resistance to oxidation, with decrease of specific gravity and more rapid

decay by exposure to the weather. The facts in the last column could only be determined, in some cases, from the hand-specimens; but the deposit of iron-ochre on some of these (*e. g.*, No. 46). plainly did not indicate the results of weathering, but either of subterranean decomposition, (an agency distinct from "weathering" in both character and duration), or merely of the transport of iron-ochre from the upper parts of the vein or gangue and its deposit upon these crystals.

This mode of experimental trial of a pyrite can evidently be used to obtain satisfactory information as to its inclination to oxidation, in comparison with one of the stable varieties, such as that of Elba, Piedmont, or Colorado, of which specimens are easily obtainable.

2. *Trial of powder in aqueous solution of bromine.* In the hope of ensuring more speedy and uniform results than those of the preceding process, the method was tried of placing weighed equal quantities of finely pulverized pyrite, from different localities, in stoppered bottles, and adding simultaneously equal volumes of a weak solution of bromine in water. However, the action was very rapid, the bromine becoming exhausted and the solution decolorized in a few minutes, in every case. This method was therefore abandoned.

TRIAL OF PYRITE POWDER BY VAPOR OF BROMINE

Collection No.	Locality.	Sp. Gr.	Per cent. of Iron rendered soluble.	Kind of Material.	Mode of Weathering.
31	French Creek, Pa.	4.997	2.43	Brilliant octahedra.	
46	Roxbury, Mass.	4.985	3.32	Brilliant striated, brass-yellow crystals, with a little iron-ochre among them.	
13	Waldenstein, Car.	5.010	3.96	Brilliant yellow crystals.	Mere traces of iron-ochre.
41	Great Barrington, Mass.	4.991	4.22	Brilliant brass yellow cubes, free from iron-ochre.	Coppery yellow tarnish.
30	Rio Marina, Elba	4.997	4.34	Brilliant brass-yellow cubes.	Freshly broken surfaces become tarnished in a few weeks, but no further action observed.
43	Traversella, Italy.	4 985	4.47	Light brass-yellow but brilliant crystals (pyritohedra).	Yellowish-brown ochreous films.
53	Colorado.	4 960	4.60	Light brass yellow and brilliant crystals.	Tarnish after some months.
102	Schoharie, N. Y.	4.809	10 35	Bright brass yellow crystalline grains.	Bright reddish brown tarnish, finally passing into iron-ochre.
111	Peekskill, N. Y.	4 374	15.20	Bright, fine-grained, bronze-yellow soft mass.	Decaying into reddish brown iron-ochre.
112	Lake Memphremagog, Me.	4.195	28.62	Mottled brass and bronze-yellow or gray, finely granular mass, soft to the knife. Distinctly non-homogeneous, but without intermixed gangue.	Decaying into reddish brown iron-ochre.

3. *Trial of powder by long exposure to the air.* A number of pulverized and weighed samples of pyrite from 16 localities had been set aside in watch glasses upon a shelf in the laboratory, and soon gave apparent evidence of gradual oxidation, by sulphurous odor, more or less decided caking of the powder, and sometimes a slight change of tint; this conclusion was confirmed by a chemical test. In the hope that a method of trial might be devised, founded on even so slow a process of atmospheric oxidation, the samples were left undisturbed for two months. The amount of iron set free as oxide was then determined by solution in sulphuric acid and titration in the usual way. The results varied from 0.5 to 2 per cent. of the quantities taken, the latter amounting to 0.5 to 3.8 grams. On arranging the figures in parallel columns with those of the specific gravities, no correspondence or progression of any kind was found. The oxidation had evidently been almost entirely superficial and soon stopped, even within a thin layer of the fine powder, by its speedy caking. The method was therefore given up as unsatisfactory.

4. *Trial of crystals in bromine-vapor.* A series of small crystals of pyrite of varying densities, all compact and with bright lustre, was then exposed to the vapor of bromine in the same way, under a large bell-glass, as in Method No. 1. Only two observations were recorded in each case, after exposures of 10 and of 50 days respectively; the latter was unnecessarily prolonged, distinctive action having been developed by the end of a fortnight.

TRIAL OF PYRITE-CRYSTALS BY VAPOR OF BROMINE.

Collection No.	Locality.	Sp. Gr.	Form of Crystal Tested.	Tarnish after 10 days.	Efflorescence of Vitriol after 50 days.	Nuclei of Pyrite left Undecomposed.
3	Marsden's Diggings, Ill.	5 023	Cube.	Dull yellowish.	Entirely decomposed, with explosion, to grayish white powder.	One small grain left; also many splinters, 24 to 200 μ in diameter.
6	Cochise Co., Ariz.	5.015	Cube.	Dull whitish film.	Grayish white to yellowish waxy powder.	None.
10	Gilpin Co., Col.	5.011	Pyritohedron.	Slightly dull ochreous film.	Thin filmy crust; crystal-form retained.	Large nucleus; surface etched in striæ.
18	Dognatschka, Hung.	5.006	Cube.	Bright as ever.	Largely altered into white flakes.	Several nuclei; surfaces delicately etched.
22	Central City, Col	5.003	Pyritohedron.	Dull orange film.	Mostly to a grayish white powder.	Several small grains and particles.
26	French Creek, Pa.	5.001	Cube.	Dull yellowish.	Mostly decomposed, with explosion, to yellowish white powder.	Abundant little angular splinters.
31	French Creek, Pa.	4.997	Octahedron	Bright but iridescent.	Waxy yellowish white crust; form retained.	A large nucleus; surface etched.
41	Great Barrington, Mass.	4 991	Cube.	Slight yellowish tinge in spots.	Yellowish white powder, grayish in part.	One small grain.
43	Traversella, Italy.	4 985	Cube.	Orange films in small spots.	Thin white crust, form retained.	Large nucleus; curiously etched in lines.

TRIAL OF PYRITE-CRYSTALS BY VAPOR OF BROMINE.—*Continued.*

Collection No.	Locality.	Sp. Gr.	Form of Crystal Tested.	Tarnish after 10 days	Efflorescence of Vitriol after 50 days	Nuclei of Pyrite left Undecomposed
54	Cornwall, Pa.	4 957	Cubo-octahedron	Dull yellowish	Entirely decomposed, with explosion, to a yellowish white waxy mass of powder and scales.	None
62	Franconia, N H	4 941	Cube.	Dulled very slightly	Waxy greenish white flakes and lumps.	A very few particles left.
71	Weehawken, N. J	4,919	Octahedron	Yellowish tinge	Entirely decomposed, with explosion, to a yellow, gray and white powder.	None.
84	Hazelton, Pa.	4 907	Cube	Dull yellowish	About half decomposed, with explosion, to bluish gray powder.	Many splinters, some with etched faces.
91	Mahanoy City, Pa	4 905	Cube.	Dull yellowish, with abundant cracks.	As above	As above.
96	Somerville, Mass	4 843	Cube	Dull yellowish	Grayish crusts, with groups of white crystals	Large nuclei remaining.
102	Schoharie, N. Y.	4 809	Pyritohedron.	Dull yellowish film	Yellowish crust, waxy or powdery ; form retained	Solid but etched.
104	St. Creac, Pyrenees	4 780	Cube	Dull tarnish.	Blackish gray powder, with some waxy, yellowish white crystals	None.

These experiments brought out the following facts:

First. The effect of oxidation, during the first ten days, appeared to the eye to be confined to more or less loss of polish, caused by a gradually over-spreading film of tarnish. A latent process of internal decomposition was however in progress, only in one case suggested (No. 91), by the finely cracked surface. The gradual disintegration and increasing strain produced by the internally developed films of vitriol finally resulted in sudden rupture, with explosion of the loose and bulky vitriol-powder. Minute sharp splinters of fractured pyrite often abounded through this powder. This reaction is markedly characteristic of the marcasitic and lighter varieties of pyrite, toward the bottom of the series. The relationship is apparent, between these miniature explosions under artificial conditions of oxidation, and the well-known natural explosions of masses of the mineral during weathering. On the purer pyritic and heavier varieties, the action differed by the formation of a thin film or crust of vitriol on the outside of the crystal, and by the retention of crystalline form, even when the vitriolic decomposition became complete; the attack was almost or entirely external, and no internal strain or sudden rupture ensued.

Secondly. The presence of enclosed impurities was shown by green, gray or black tints of the efflorescent vitriol, the latter sometimes indicating the enclosure of carbon in the pyrite of Coal-shales (Nos. 84 and 91) and of carbonaceous argillyte (No. 104), and sometimes that of lead or other impurities (No. 3). Such impurities have doubtless exerted an accessory influence toward ready oxidation by facilitating the entrance of the corrosive agent. The same experiment was repeated upon another set of bright crystals, with the substitution of the vapors from fuming nitric acid in place of those of bromine.

TRIAL OF PYRITE CRYSTALS BY VAPOR OF NITRIC PEROXIDE.

Collection No.	Locality.	Sp. Gr.	Form of crystal tested.	Tarnish after 10 days.	Efflorescence after 50 days.	Nuclei of Pyrite left undecomposed.
3	Marsden's Diggings, Ill.	5.023	Cube.	Tarnished.	Decomposed with explosion to grayish and white powder.	A few granules and many fine splinters.
8	Alabama, N Y.	5.011	Cube.	Tarnished.	Like No. 17.	Large grains.
10	Gilpin Co., Col.	5.011	Pyritohedron	Bright as ever.	A mere yellowish film, without powder; form perfect.	No trace of disintegration.
17	Pinal Co., Ariz.	5.007	Cube.	Bright as ever	About ⅛ altered to yellowish white powder: form retained	Two large grains.
31	French Cr'k, Pa.	4 997	Octahedron.	Bright	White vitriol, stained reddish externally: form retained	None.
39	Bristol, Ct.	4 993	Cube	Tarnished.	White and gray powder; form retained.	One crystal merely crusted with vitriol
41	Gt. Barrington, Mass.	4 991	Cube.	Bright as ever.	Like No. 17.	Large grains.
46	Roxbury, Mass.	4.985	Cube.	Bright.	Decomposed with explosion to bulky grayish and brick-red powder.	Some grains and many fine splinters.
51	St. Lawrence Co, N. Y	4 970	Cube.	Tarnished.	Decomposed to abundant white powder	None.
55	Guanajuato, Mex	4.954	Cube	Dulled lustre.	Soft gray and white powder	A few granules.
62	Franconia, N. H.	4.941	Cube	Tarnished	Mostly to a white powder, with some waxy yellow flakes	A few granules.
71	Weehawken, N. J.	4 919	Octahedron.	Tarnished.	Yellow'h white powder, partly grayish.	A few tarnished particles
91	Mahanoy City, Pa.	4 905	Cube	Dull tarnish.	About ⅛ decomposed, with explosion, to soft gray powder, in parts white or black	Large grain.
96	Somerville, Mass.	4.843	Cube.	Dull tarnish.	Decomposed to abundant powder, as in No. 3.	One cube merely encrusted with vitriol.

The same results are displayed in this series as in the preceding, with no apparent advantage from the change of reagent.

B. Microscopical Examination of Etched Nuclei.

The evidences already obtained have indicated the intermixture, in most specimens of iron-pyrites, of two species, the one strongly resistant, the other readily submitting to any process of oxidation by either natural or artificial agency. The question was thereby suggested whether the surface of a pyrite-crystal undergoing such process of corrosion might not exhibit minute cavities corresponding to the crystalline form of the particles of the more readily attacked mineral, marcasite, supposed to be enclosed. The surfaces of the nuclei or undecomposed remnants of pyrite, referred to in the last columns of the two preceding tables, were therefore carefully examined under low magnifying powers, up to 200 diameters, on the stage of a microscope. Occasionally some rhombic forms, more or less indistinct, were noticed in the cavities on some of these pitted surfaces, but none which could be with certainty assigned to the removal of marcasite-crystals. The results of the microscopical examination of these artificially etched surfaces therefore correspond essentially to those obtained from the weathered and decayed specimens of pyrite, already reported. In most cases, it is probable, the intermixture is far too intimate and minute for identification in this way—it may be, even molecular; the normal crystalline form may also have been rarely developed in grains enclosed under such conditions. But the examination, though unsuccessful in its direct object, brought out facts of much interest concerning the internal structure of these specimens, of which the principal may be briefly summed up in the following Table;

ETCHED NUCLEI OF PYRITE.

Collection No.	Locality.	Sp. Gr.	Etching Agent.	Characteristics of the Etched Surface.
3	Marsden's Diggings, Ill.	5.023	Br	Many coarsely crystalline irregular grains, projecting above a fine matrix seamed up into minute squares by the cubical cleavage.
6	Cochise Co., Ariz.	5.015	Br	Very minutely and uniformly mammillated to a shagreen-like surface, caused by projecting spherules and cubes.
10	Gilpin Co., Col.	5.011	Br	A similar shagreen-like surface, but with a few projecting coarse grains. Granules of the groundmass mostly cubes and square plates, in rounded aggregations or spherules.
10	Gilpin Co., Col.	5.011	NO^2	The same, with the round or elliptical form of the spherules and pits well marked: diameter, 9.8 to 66.7 μ[1], averaging about 40 μ (1-625 inch) Granules about 6 μ in diameter.
8	Alabama, N. Y.	5.011	NO^2	Shagreen-like spherules, 17 to 82 μ, averaging 44 μ; often rectangular, and commonly made up of exceedingly minute cubes.
18	Dognatschka, Hungary.	5.006	NO^2	The same shagreen-like surface. Granules less distinct and regular, averaging 3 7 μ in diameter.
22	Central City, Col.	5.003	Br	Minutely shagreen-like. Many round pits. Also larger elliptical grains projecting. Widened cracks abundant.
26	French Creek, Penn.	5.001	Br	Minutely shagreen-like, the component cubes about 4 μ in diameter. Surface furrowed by short branching lines.
31	French Creek, Penn.	4.997	NO^2	Much roughened by irregular lines and clefts, with small shagreen-like patches here and there.
31	French Creek, Penn.	4.997	Br	Coarser grains (sometimes octahedra) projecting above the predominant, very fine grained groundmass.
39	Bristol, Conn.	4.993	NO^2	Like No. 26

[1] The standard μ or micra equals 0.001 millimeter, or about 1–25,000 of an inch.

ETCHED NUCLEI OF PYRITE.—*Continued.*

Collection No.	Locality.	Sp. Gr.	Etching Agent	Characteristics of the Etched Surface.
43	Traversella, Italy.	4.985	Br	Minutely shagreen-like, or merely pitted on some faces. Cracks and cleavage-lines etched out.
46	Roxbury, Mass.	4 985	NO^2	Coarser shagreen-like surface. Spherules often elliptical, sometimes square. Some surfaces merely pitted.
55	Guanajuato, Mex.	4 954	NO^2	Finely granular mass, thoroughly seamed by very minute clefts. Slight differences in the color and lustre of the granules.
84	Hazelton, Pa.	4.907	Br	A minutely spongy, yellowish white and deeply fretted network; the cavities and grains about 4 μ in diameter Cleavage lines marked by the projection of solid brilliant yellow ridges.
91	Mahanoy City, Pa.	4.905	NO^2	Minutely fretted and pitted like the preceding, with many short furrows, and rarely projecting octahedra.
91	Mahanoy City, Pa.	4.905	Br	Like the preceding. Rarely, a few isolated spherules.
96	Somerville, Mass.	4.843	NO^2	Coarse grains projecting above a fine grained groundmass. Cleavage-lines etched out deeply, sometimes producing six sided grains by crossing.
102	Schoharie, N. Y.	4.809	Br	Commonly pitted, and furrowed by irregular clefts. Abundant particles of gray quartz included, separated by a network of bright pyrite.

When it is considered that the specimens subjected to the oxidizing tests were, in all cases, crystals selected for apparent purity, with brilliant faces and generally a strongly marked conchoidal fracture, it will be seen that these peculiarities of etching point to remarkable differences in structure and in latent composition, and to an unexpected lack of homogeneity in most specimens. Of these differences the proofs thus obtained were far more conclusive than those by the ordinary microscopic examination of the natural crystal-faces or fracture-surfaces. The following five varieties of etching were distinguished, and

of some of them photo-micrographs are presented in the two Plates illustrating this paper.

a. (*Plate* 8, *Figs.* 1 and 2). A mammillated or a pitted surface, more or less uniform, best compared to that of shagreen in miniature. The pitting alone, at first glance, might suggest the regular erosion of a homogeneous material into rounded cavities, as it progressed uniformly from separate scattered points. A distinctly oolitic structure, however, is shown on the mammillated surfaces, by the projecting papillæ, or the pits left by their removal, which plainly correspond to spherules, 9 to 82 micras in diameter, which vary, however, considerably in form, being often elliptical, rectangular, or represented by cubes. They usually appear to be constituted of exceedingly minute granules, 3 to 6 micras in diameter, sometimes spherical in form, often cubical; these minute cubes occasionally show a different orientation of their axes from each other and from the main crystal, as if grouped concentrically around scattered nuclei. This shagreen-like surface is predominant on most of the etched faces of the heavier crystals of pyrite, down to the specific gravity of 4.98. The only apparent exception, that of Specimen No. 3, at the head of the Table, is the one whose density—as we have already had evidence—is probably unduly increased, partly by enclosure of galenite. I therefore believe this oolitic structure to be characteristic of normal pyrite, and this shagreen-like surface, when general over an etched crystal, to bear testimony to the purity and stability of the mineral.

b. (*Plate* 9, Fig. 3). A surface roughened by coarse irregular projections above an even plane, very finely granular and sometimes shagreen-like. The structure here consists of coarsely crystalline yellow grains, sometimes octahedra or cubes, of pure pyrite, resisting oxidation, scattered in greater or less number through a fine grained and impure groundmass, which may be lighter in color and yields more readily to oxidation. This heterogeneous structure may occur in some of the heavier varieties, but is characteristic of those with a specific gravity below 4.98 and with inferior stability.

c. A surface either ribbed by projecting parallel yellow ridges, marking the cleavage planes, or furrowed by lighter colored clefts and lines which have been etched out. In these we have

apparent evidence of contraction or fracture of the material during its formation, and of the filling in of the clefts by later deposit, sometimes of purer resistant material, and sometimes of impure material which yields first to oxidation. Hexagonal figures are often thus produced by the mutual intersection of the cubic and octahedral cleavages of the mineral. This constitution is only seen in the lighter unstable varieties, with specific gravity below 4 98.

d. (*Plate* 9, Fig. 4). A spongy cellular surface, deeply fretted into an irregular minute network. This clearly shows the intimate and uniform intermixture throughout, in large proportion, of a constituent yielding readily to corrosion. Such a structure characterizes the light pyrite common in bituminous coal, in which the impurities apparently consist of both marcasite and carbonaceous matter, and lower the specific gravity to 4.90. In this constitution we have unmistakable proof of great instability.

e. An irregularly pitted and furrowed surface, with distinct differences in the color, lustre and surface of the constituent grains. These phenomena indicate the enclosure of gangue-matter, quartz, or other impurities, with a decrease of the specific gravity to the lowest extreme, as in No. 102 at the bottom of the Table. Though the pyrite present, in cases like this, may itself possibly be pure and free from marcasite, the conditions of the structure are peculiarly favorable for rapid oxidation, and such specimens are probably always highly unstable.

While therefore I have not succeeded in determining, for the marcasite enclosed in pyrite, morphological characteristics by which to establish its presence directly, its minute particles reveal themselves, as to proportion and mode of distribution, by their influence on the erosive etching of the enveloping groundmass. This seems then to afford a useful means of investigation, if due care be given and sufficient area of etched surface be subjected to the microscopical examination.

III. Determination of the Density of Pyrites.

It has been already manifest that the records of the few experiments, which have yet been made on the specific gravity of these minerals, furnish us with little satisfactory information on many important points : *e. g.*, the purity of the material un-

der trial, as ensured by preliminary microscopical examination; the proper mode of experiment, *i. e.*, on coarsely crushed material, rather than on complete crystals; the exact crystalline form, as an assurance of identity; and any data connected with the tendency to decomposition of each specimen under investigation. I have now to present the results of a careful examination of a large number of specimens[1] of iron-pyrites in my own cabinet, from American and foreign localities, chiefly crystals selected for their perfect forms and apparent purity. A brief description is first given of every specimen in the collection of each of the three minerals, concluding with the apparent evidences of visible decomposition. In the tables, the collection-number of each specimen is given in the first column, and its locality in the second. The specimens of each mineral are numbered and arranged in the order of decreasing specific gravity, stated in the third column. A large part of these determinations was made, with the help of two assistants, on material which I had previously selected, crushed, picked out and examined under the microscope. In most instances, the specimens, crushed to coarse powder, were previously freed from the film or stain of adhering iron-oxide by short digestion in dilute hydrochloric acid; this was thoroughly washed out, before the specific gravity determination was taken. The exceptional cases, in which this preliminary digestion in acid was omitted as unnecessary, are indicated by an asterisk, attached to the collection-number of the specimen in the first column. In the fourth column is recorded the actual weight in grams of the amount of mineral used in the preceding determination, as one element of judgment of its accuracy. In the tables for marcasite and pyrite, other columns present my view (explained beyond) of the theoretical mineralogical constitution of each specimen; and in the table for pyrite, the prevailing crystallographic forms are presented in the sixth column. At the close of each preliminary description, as well as in the last column of every table, are recorded the evidences of decomposition apparently exhibit-

[1] My grateful acknowledgements are due to Profs. B. K. Emerson, T. Egleston, J. S. Newberry, and D. S. Martin, and Messrs. B. B. Chamberlin, J. M. Habirshaw, and B. G. Amend for the contribution of thirty specimens for this investigation.

ed by the hand-specimen. It will be seen that these vary widely, from a barely visible iridescence, to efflorescence, to a thick incrustation by iron-ochre, and to complete hepatic alteration. Various conditions, however, have of course occurred in the vein or rock-matrix once occupied by the specimen ; in many cases it has been completely enveloped and thus protected from oxidation, however perishable ; in others, though stable, the crystals of pyrites have probably received stains or deposited crusts of iron-oxide, derived from the decomposition of associated minerals or of their matrix ; in other instances, the specimens have been exposed directly to the weathering influence of the atmosphere. The conditions of oxidation have therefore been too variable to permit entire reliance on the present indications of decomposition, as a measure of stability.

A. PYRRHOTITE.

A few interesting specimens of this mineral, incidentally collected, were included in the investigation, and will be first described.

No. 1. Pyrrhotite. Ore Knob, Ashe County, North Carolina. Massive, with iridescent, dark bronze-colored surface, and very irregular fracture. Some division-planes run approximately parallel, and are more or less wavy. On fresh fracture, an indistinct fibration and glistening light reddish gray surface, with slight bronze tinge, which deepens in shade on short exposure. Apparently homogeneous and pure, except from a few small enclosed granules of golden yellow chalcopyrite. *Decomposition* : abundant iridescent or dark reddish brown films over the numerous intersecting surfaces of fracture. Under the microscope, a beautiful and general iridescence is seen over the fresh and very uneven fracture, but no visible impurity.

No. 2. Pyrrhotite. Schneeberg, Tyrol. A drusy crust, upon a fine grained veinstone which is a mixture of pyrrhotite and gray quartz. Brilliant reddish bronze hexagonal plates, with edges deeply striated. Strongly magnetic. On fresh fracture, reddish black, uneven, and glistening. Soft to the knife, with dull brownish black streak. *Decomposition*: the surface of fracture becomes yellowish and reddish on exposure ; the surface of the plates is largely covered by tarnish, sometimes dark blue and iridescent, while the interstices of the surrounding

veinstone are colored by a film of reddish to reddish brown iron-ochre.

No. 3. Pyrrhotite. Elizabethtown, Ontario, Canada. A tabular mass, apparently a fragment of an imperfect crystal imbedded in calcite. Fresh fracture, gray, glistening with high lustre, and uneven. Strongly magnetic. Small geodes in the vicinity are studded with minute crystals, brilliant bronze-colored, hexagonal, with many modification-planes. *Decomposition* : dull reddish bronze-colored tarnish, iridescent in places.

PYRRHOTITE.

No.	*Locality.*	*Sp. Gr. at 15° C.*	*Weight taken, in grams.*	*Evidences of tendency to decomposition.*
1	Ore Knob, N. C.	4.661	8.119	Iridescence.
2	Schneeberg, Tyrol.	4.596	2.298	Tarnish and ochreous film.
3	Elizabethtown, Can.	4.542	1.039	Dull tarnish.

In No. 1, the density is undoubtedly increased by the intermixture of a small proportion of pyrite throughout the massive ore. In No. 3, the figures are lower than those obtained by both Smith and Harrington (Nos. 4 and 12 of Table in Part I, of this paper, page 371). The determination in No. 2 was made with the utmost care, by scraping the shining crystals from a choice specimen, digesting them repeatedly in a weak solution of tartaric acid to remove adhering iron-oxide, and then picking out the pure crystals under a loup. The specific gravity obtained agrees exactly with the average, 4.597, of the sixteen best determinations already published (Part I, page 372), and this figure, (or 4.6, as already suggested by Rammelsberg), probably approximates very closely to the density of normal pyrrhotite.

In this connection it may be added, in regard to troilite, that its superior specific gravity, 4.681—4.817, which Rammelsberg has discussed[1] with reference to the constitution of pyrrhotite, appears to be connected with two conditions: the intense surrounding compression, which has attended the solidification of the meteorite and its strong crystallization, (indicated by the Widmannstättian figures), during cooling from the state of fusion ; and also, it may be, the enclosure of microscopic films and

[1] Zeits. d. d. geol. Gesells., (1864), XVI, 271.

strings of metallic iron, corresponding to the veinlets visible to the eye, often seen within the margins of the troilite-nodules. Therefore it would seem unadvisable, as already suggested, to consider at all this abnormal form of iron-sulphide in any reference[1] to the densities of the kinds of iron-pyrites produced on our own planet.

B.—Marcasite.

The following specimens of this mineral were carefully studied, and their densities determined with all precautions to anticipate oxidation.

No. 1. Marcasite. Cumberland, England. Hollow incrustation-pseudomorphs after barite, implanted on a group of barite-crystals. The crusts are grayish white to tin-white and splendent on fracture, with surfaces drusy with pseudo-octahedrons or rhombic pyramids, whose smooth, rectangular, terminal faces (the basal pinacoid, OP) project but slightly; a few minute rhombic prisms also occur, and some hexagonal though apparently triangular twins. Under the microscope, no impurity whatever was seen, to account for the high density obtained. The specimen, as received, was mislabelled "pyrite."

Evidences of Decomposition: a copper-red tarnish with rather dull iridescence.

No. 2. Marcasite. Canterbury, England. A rounded bronze yellow nodule, with mammillary surface, exactly like No. 5, with the apices of the square pyramids all rounded. From the Gault formation. Strikes fire readily with steel. Fresh fracture, tin-white, with yellow iridescence upon the faces of the bladed plates radiating from the nucleus; this implies incipient decomposition throughout the apparently compact nodule. *Decomposition*: a rather dull bronze tarnish over the exterior surface.

No. 3. Marcasite. Nova Scotia. A spherical nodule of bright orange-yellow tinge, imbedded in grayish clay. The surface is drusy with truncated rhombic pyramids, apparently nearly square, slightly projecting, as in No. 1, with composite six-sided plates visible on their sloping faces, as well as a few minute implanted rhombic prisms. Fresh fracture, grayish

[1] Rammelsberg, Pogg. Ann., (1864) CXXI, 370.

white, with a slight yellowish tinge caused by incipient tarnish on the faces of intersecting bladed plates, sometimes drusy with microscopic crystals of the same mineral.

Decomposition : a slight orange-yellow tarnish.

No. 4. Marcasite. Bohemia. A nodule made up of clustered groups of crystals encrusting a fibrous blackish nucleus. Composite platy rhombic pyramids, sometimes with the rectangular terminal faces (OP) ; also in striated twins. On fracture, grayish white and brilliant. The crystals only were used for the specific gravity determination.

Decomposition : on the crystals, a dull blackish film and bluish iridescence ; on the nucleus, some efflorescence of white and yellow vitriol, chiefly ferrous sulphate, which corrodes the specimen-label.

No. 5. Marcasite. Folkestone, England. An elongated rounded nodule, with finely granular nucleus. The outer crust is grayish white and brilliant on fracture, coarsely radial with thin platy structure. Surface made up of thin rhombic plates of the usual six-sided form, in nearly square mammillary aggregations ; also twinned triangular plates. The terminal faces (OP) are nearly square. From the Chalk. *Decomposition :* bronze yellow tarnish.

No. 6. Marcasite. Belgium. Very irregular nodule with rough prongs and projections. Grayish white and brilliant on fracture. Surface drusy with composite quadrilateral pyramids, made up of scaly, ill-developed plates, sometimes octagonal ; terminal face (OP) broad. Strikes fire readily with steel. *Decomposition :* a fresh fracture soon becomes yellowish. Outer surface covered by a dull brownish yellow and brownish black film, inky to the taste, with traces of an efflorescence of white vitriol.

No. 7. Marcasite. Hannover, Germany. Tooth-like rhombic pyramids of the type of Galena, Ill., and twinned forms, with solid angles bevelled and faces slightly striated. Grayish white and brilliant on fracture. *Decomposition :* dull blackish gray tarnish, sometimes with a blue iridescence.

No. 8. Marcasite. Marsden's Diggings, Galena, Illinois. A coarsely nodular crust upon sphalerite. Grayish white and brilliant on fracture. Surface studded with tooth-like rhombic

pyramids, with the terminal face (OP) rounded and finely striated. *Decomposition:* a bright greenish gray or bronze tarnish, spotted with copper-red or iridescent films. Minute yellowish and reddish white particles of efflorescent vitriol, chiefly ferric sulphate.

No. 9. Marcasite. Galena, Illinois. Thin drusy crusts, on cubes of galenite, adhering to sphalerite. Sharp tooth-like rhombic pyramids, like those of Nos. 7 and 8, with many twinned forms; terminal faces (OP) sometimes nearly square, sometimes linear and barely visible. Grayish white and brilliant on fracture. *Decomposition:* rather dull brownish yellow tarnish over the surface.

No. 10. Marcasite. Champion, Jefferson County, New York. A coarsely fibrous crust with bunches of radial structure, upon a granular nucleus made up of grains of radial structure. Grayish white and brilliant on fracture. Over the surface of the crust the radiating bladed fibres terminate in the apices of tooth-like pyramids, whose terminal faces (OP) are unusually broad and nearly square; some twinned forms also occur. Specimen, as received, mislabelled "pyrite." *Decomposition:* yellow iridescent tarnish on some fibres, and reddish brown iron-ochre spread over the surface of the crust.

No. 11. Marcasite. Folkestone, England. Spear-headed deeply striated twinned crystals and groups, imbedded in ash-gray chalk. Grayish white and brilliant on fracture, and very hard. *Decomposition:* a bright yellow or blue iridescent film, or a dull bronze-colored tarnish, passing into a soft crust of orange-colored iron-ochre.

No. 12. Marcasite. Joplin, Missouri. A thick crust of long rhombic prisms, composite and platy and marked by strong striation, producing a fibrous appearance. All the faces are curved. Grayish white and brilliant on fresh fracture. Associated with sphalerite and quartz. *Decomposition:* the fresh fracture soon colored yellowish; the surface of the crystals rendered beautiful and brilliant by a bronze-yellow iridescent tarnish.

No. 13. Marcasite. Central Park, New York City. A compact shining crust, grayish white and brilliant on fresh fracture and imperfectly fibrous, adhering to biotitic gneiss. The botryoidal surface resembles those of Nos. 2 and 5, being covered

by the rectangular, nearly square, terminal faces (OP) of similarly arranged rhombic plates and triangular twins. The massive mineral and its dark greenish brown powder both emit a strong sulphurous odor, which however does not blacken paper moistened with lead-acetate. Streak, brownish black, very slightly greenish. *Decomposition:* the fresh fracture soon assumes a yellowish tinge: a yellowish brown film of iron-oxide covers the hollows in the botryoidal surface.

No. 14. Marcasite. Dover Cliffs, England. A brilliant cluster of spear-headed crystals—broad, striated twinned plates, —resembling those of No. 11, imbedded in light gray chalk. Grayish white and bright on fracture. *Decomposition:* a slightly iridescent tarnish, with red, blue and yellow colors.

No. 15. Marcasite. Canada. A compact crust, steely white and brilliant on fracture, with curved finely fibrous structure; mixed with sphalerite. Under the microscope, the fracture shows the tin-white splendent faces of striated columns. *Decomposition*: bronze-colored tarnish, yellow or iridescent in places, with little pockets of reddish iron-ochre.

No. 16. Marcasite. Galena, Illinois. A thick crust, grayish white and brilliant on fracture, with radial fibrous structure. Surface covered by grouping of twinned rhombic prisons, wedge-shaped and composite, made up of striated six-sided plates. *Decomposition*: a beautiful orange and blue iridescence, with high lustre.

No. 17. Marcasite. Galena, Illinois. A large stalactite, whose core consists of sphalerite and pyrite, encrusted by a thick coating of marcasite, in large radiating tooth-like rhombic pyramids, highly modified; grayish white and brilliant on fracture. The coffin-shaped faces of the brachydome (m $\breve{P}\infty$) are invariably even and brilliant, but little marked by lines of composite structure or of cleavage. These faces and those of the basal pinacoid (OP) are unusually hard, about 6.5, being just scratched by a file and by quartz, but not by orthoclase. The faces of the macrodome are less bright and commonly marked by rhombic composition-lines; these are evidently softer, about 6 in the scale of hardness, being deeply scored by a file and even just scratched by orthoclase. *Decomposition*: dull bronze-colored tarnish, without styptic taste.

No. 18. Marcasite. Galena, Illinois. A bright crust, covered by the rectangular, nearly square faces (basal pinacoid) of rhombic pyramids, grayish white and brilliant on fresh fracture. *Decomposition*: dull yellow tarnish.

No. 19. Marcasite. Galena, Illinois. A hemispherical nodule, made up of concentric crusts, very finely fibrous, grayish white and brilliant on fracture. *Decomposition* : a dull bronze-colored tarnish and abundant efflorescence of white vitriol, chiefly ferric sulphate, with a little ferrous sulphate.

No. 20. Marcasite. Galena, Illinois. A crust of radial finely bladed structure, grayish white and brilliant on fracture ; upon grayish crystalline limestone. The outer surface is studded by projecting tooth-like aggregates of the usual modified rhombic pyramids and striated twins. The rectangular terminal faces (OP) are very narrow and even, linear, like chisel-edges. *Decomposition* : beautiful iridescence, blue and orange, with high lustre.

No. 21. Marcasite. Littmitz, Bohemia. A crust like the preceding, on quartz ; with fine, fibrous radial structure, and grayish white and brilliant on fracture. Surface covered by tooth-like quadrilateral domes of twinned rhombic pyramids, with terminal faces (OP) linear. *Decomposition* : a rather dull yellowish tarnish, partly iridescent, on the faces of the crystals.

No. 22. Marcasite. Joplin, Missouri. Thin crusts, grayish white and brilliant on fracture, lining cavities in a brecciated limestone, in close association with modified cubes of pyrite, and crystals of sphalerite and greenockite. Surfaces drusy with minute rhombic prisms of marcasite, somewhat modified, truncated pyramids, and striated twins. *Decomposition* : a rather dull brownish yellow tinge—in part, a blue and yellow iridescent tarnish, on the surface and on old fractures.

Concretionary nodule. Galena, Illinois. A large nodule of concretionary structure, consisting successively, (passing from the centre outward), of two distinct layers of marcasite, *a* and *b*, and a crust of pyrite, *c*, on the outside.

No. 23. (*a*, Fibrous nucleus). Marcasite. A bright core of exceedingly fine fibrous structure, marked across the fibration by delicate concentric lines, often six to a millimeter, which are the edges of shining drusy mammillary surfaces ; these surfaces

are commonly separated by finely granular layers, sometimes one to three millimeters in thickness, tin-white and brilliant on fresh fracture. *Decomposition*: on the mammillary surfaces, an iridescent tarnish: on the granular layers, a bronze-colored tinge, with some delicate efflorescence of white vitriol.

No. 24. (*b*, Middle layer, granular crystalline). Marcasite. A layer in which the concretionary lines and fibrous structure are more strongly marked, and the granular layers distinctly exhibit the simple six-sided rhombic plates, coffin-shaped, and some triangular twins, presenting the square terminal faces. Some of the abundant drusy surfaces in this layer consist of composite rhombic pyramids, made up of six-sided coffin-shaped plates, presenting their terminal faces (OP) in close aggregations, as fine parallel lines. *Decomposition*: as in the layer No. 23, and with brilliant iridescent tarnish upon the visible crystals in the drusy cavities.

(*c*, Outer crust). Pyrite. (See No. 12 in Table of Pyrite, beyond). A coarsely fibrous or columnar layer of pyrite, pale yellowish white and brilliant, with Sp. Gr. = 5.010.

No. 25. Marcasite. Galena, Ill. A thick crust on sphalerite, light grayish white and bright on fracture. Surface covered by symmetrically arranged and closely aggregated, twinned rhombic crystals, often finely striated. *Decomposition*: a beautiful and lustrous iridescence, green, yellow and light crimson.

No. 26. Marcasite. Hazelgreen, Wis. Bright crusts, lining cavities in calcite-veins through limestone; grayish white and brilliant on fracture. Surface covered by curved, finely striated and lamellated groups of rhombic prisms, wedge-like rhombs of the Joplin type, (No. 12). *Decomposition*: bronze-colored and iridescent greenish tarnish.

Concretionary nodule. Crow Branch Mine, Wis. Bright compact drusy crusts, associated with cubes of galenite, upon a fine-grained, dull gray nucleus.

No. 27. (Outer crust). Marcasite. Bright and massive crypto-crystalline material, with drusy cavities, grayish white and brilliant on fresh fracture. Finely striated rhombs and twin crystals, and thin brilliant plates with serrated edges, a miniature form of "cockscomb pyrites". *Decomposition*: a sulphurous odor is evolved by the material when bruised.

No. 28. (Nucleus). Marcasite. Dull gray and exceedingly fine-grained material. *Decomposition* : dull iridescent yellowish tarnish without, and, within, a little delicate efflorescence of acicular white vitriol.

Marcasite. Jefferson County, N. Y. Small drusy flakes, grains and particles, sparkling in a blackish gray limestone, (Trenton group). On digestion of the rock in dilute hydrochloric acid, a little hydrogen disulphide was evolved and a considerable insoluble residue was left, consisting of these bright grains, many particles of white quartz, and a large amount of carbon in fine dull black powder. The following two materials were selected for examination.

No. 29. (Crystalline flakes). Marcasite. Glittering plates of irregular form and size and with drusy surfaces, mixed with slender brilliant needles and fine glittering powder ; tin-white and brilliant, both on the acid-washed surfaces and on fresh fracture. An abundance of quartz particles becomes visible, under a low power of microscope, adhering to and imbedded in the crusts. To their presence and, probably, that of enclosed particles of the amorphous carbon, we may attribute the low specific gravities obtained from this material (4.51—4.58), like that of pyrrhotite. The preliminary digestion in acid ensured the removal of an original trace of the latter mineral, and not a particle of the powder was found to be attracted by the magnet. *Decomposition :* on exposure to the air, a few delicate white needles of vitriol were detected under the microscope, with minute white grains of fibrous radial structure.

No. 30. (Selected crystals). Marcasite. Brilliant grayish white crystals, mostly twins of the usual type, deeply striated, and sometimes triple. Under the microscope, there appear also thin six-sided plates with striated edges and high lustre, much resembling the hexagonal plates of pyrrhotite (*e. g.*, No. 2 from Schneeberg) ; these may be pseudomorphous in marcasite, after pyrrhotite.

No. 31. Marcasite. Schneeberg, Saxony. A very fine-grained, glittering, crypto-crystalline mass, grayish white and brilliant on fracture, made up of striated wedge-shaped twins and rhombs of marcasite, with particles of grayish quartz, red garnet and scales of a colorless mica. A few slightly magnetic particles were

obtained, by means of a magnet, among the crushed powder. The material selected for the specific gravity determination was found, under a low power of the microscope, in reflected light, to consist of an intimate intermixture of the shining grayish white marcasite and white quartz; the lowering of the specific gravity to that of pyrrhotite appears therefore to be merely due to this accidental ingredient. *Decomposition:* a bronze-yellow to brownish black tarnish on the surface of most crystals, and a minute efflorescence of white vitriol within the mass.

MARCASITE.

No.	Locality.	Sp. Gr. at 15°.5 C.	Weight taken, in Grams	Supposed Constitution. Marcasite, S. G 4.80	Pyrite, S. G. 5 01	Tendency to Decomposition.
1	Cumberland, Eng.	4.987	5.032	10.55	89.45	Slight tarnish.
2	Canterbury, Eng.	4 949	4.077	28.17	71.83	"
3	Nova Scotia.	4.943	3.341	30.99	69.01	"
4	Bohemia.	4.942	1.363	31.45	68.55	"
5	Folkestone, Eng.	4.935	4.377	34.74	65.26	"
6	Belgium.	4.915	3.701	44.18	55.82	Slight tarnish and vitriolescence.
7	Hannover, Germ'y.	4.909	1.944	47.03	52.97	Slight tarnish.
8	Marsden's Diggings, Galena, Ill.	4.903	3.486	49.89	50.11	Slight tarnish and vitriolescence.
9	Galena, Ill.	4.895	5.050	53 73	46.27	Slight tarnish.
10	Champion, N. Y.	4.888	5 018	57.08	42.92	Tarnish and ochreous film.
11	Folkestone, Eng.	4.887	2 445	57.56	42.44	Tarnish and ochreous film.
12	Joplin, Mo.	4 885	2.614	58.51	41 49	Tarnish.
13	New York, N. Y.	4 882	3 762	59.93	40.07	Tarnish and ochreous film.
14	Dover, Eng.	4 881		60.41	39.59	Slight tarnish.
15	Canada.	4.872	1.445	64.76	35.24.	Tarnish and ochreous film.
16	Galena, Ill.	4.868	1.708	66.69	33.31	Tarnish.
17	"	4.867	2 484	67.17	32.83	"
20	"	4.863	2.069	69.10	30.90	"
21	Littmitz, Bohemia.	4.859	3 618	71.05	28.95	"
22	Joplin, Mo.	4.858	3 628	71.53	28 47	"
24	Galena, Ill.	4 827	2.193	86.65	13 35	Tarnish and vitriolescence.
25	"	4.812	2 239	94.07	5 93	Tarnish.

MARCASITE.—*Continued.*

No.	Locality.	Sp. Gr. at 15°.5 C.	Weight taken, in Grams.	Supposed Constitution. Marcasite, S. G. 4.80	Pyrite, S. G. 5.01	Tendency to Decomposition.
23	Galena, Ill.	4 807	2.315	96.52	3.48	Tarnish and vitriolescence.
26	Hazelgreen, Wis.	4.805	2.797	97.50	2.50	Tarnish.
27	Crow Branch Mine, Wis.	4.720	0.996			"
28	Crow Branch Mine, Wis.	4.654	2.019			Tarnish and vitriolescence.
30	Jefferson County, N. Y.	4.584	4.849			"
31	Schneeberg, Saxony.	4.537	1.141			"
29	Jefferson County, N. Y.	4.513	2.439			"

1. *Density of normal marcasite.* In discussing these figures it is desirable, first, to deduce the probable density of pure normal marcasite. On account of the visible admixture of quartz and other impurities, the last five specimens, Nos. 27 to 31, must be eliminated. In the remainder there is evident a halting of the figures near three points, 4.94, 4.88, and 4.86, but still a marked progression from 4.805 to 4.987, with a corresponding increase in hardness, lustre and resistance to oxidation. All the facts seem to indicate that the density is increased by admixture with the heavier mineral, pyrite, and that the average figure for marcasite, 4.9, adopted by Rammelsberg[1] as well as the other, 4,847, deduced[2] from all the figures hitherto obtained by other observers, are both too high from this cause. The true specific gravity of normal marcasite may be therefore taken as very near the figure 4.80.

2. *Latent constitution of marcasite crystals.* If then we may consider all these samples of marcasite as intimate intermixtures with varying amounts of pyrite, without change of volume, the percentage proportions of the two minerals may be

[1] Zeits. d. geol. Ges , (1864), XVI, 267.

[2] This paper, Part I, 390

calculated by the usual formula, founded on the relationship of the loss of weight to specific gravity:

$$\frac{100-x}{5.01} + \frac{x}{4.80} = \frac{100}{a}$$

in which x represents the percentage proportion of marcasite in the specimen under trial, and a the specific gravity of the specimen. For convenience, this formula may be reduced thus:

$$x = \frac{11451.4286}{a} - 2285.71$$

and in this way and by occasional interpolation the figures in the two columns have been obtained, which exhibit the supposed percentage constitution in marcasite and pyrite, corresponding to the specific gravity of each specimen. It is admitted that the density of some samples has been probably affected by other constituents, *e. g.*, it may be, by the enclosure of a little argentite (sp. gr. 7.2) and galenite (sp. gr. 7.5) in some of the samples of marcasite (Nos. 8 and 9) from Galena, Illinois, etc. But it is of equal significance that, in six other samples from that very locality, the density falls to the lowest point (Nos. 16 to 18 and 21 to 23). Again, that peculiarly brilliant, hard and stable variety of marcasite, which is found in the Chalk and Gault formations of England, presents the highest densities (Nos. 2, 5, 11 and 14), and entire freedom from heavy constituents; see analysis of No. 11 already given. The figures shown in the analyses of marcasite from other localities, by Rammelsberg, etc.,[1] bear the same testimony. It seems therefore reasonable to conclude that the main disturbing element, in the variation of the density of specimens of marcasite, must in general be the intermixture of pyrite suggested by the similar variation in physical properties. From this it will also follow that the varieties of high density at the head of the table, consisting of over 50 per cent. of pyrite, are all true paramorphs after marcasite. That the color of these is not perceptibly affected by a yellow tinge, as in the similar paramorphs described beyond under pyrite, may be due to a uniform dissemination of the molecules of pyrite in the former and their partial concentration in the latter. The paramorphs, here presented under marcasite, may also have mostly originated by

[1] Part I, 388, Analyses Nos. 7 to 10.

enclosure of pyrite during crystallization ; those described under pyrite may have been formed by a subsequent alteration of that mineral into marcasite. It is plainly indicated that marcasite possesses a remarkable force of crystallization and retention of physical properties, sufficient to impress its character even upon a 90 per cent. dilution with pyrite (Specimen No. 1)

3. *Color and lustre of marcasite.* The observations throw further light on a question concerning which a curious uncertainty seems still to prevail, *viz.*, the color and lustre of marcasite. On this point the following are the statements by several authors.

Pale or grayish bronze-yellow, sometimes almost greenish gray (Nicol, Manual of Min., 1849).

Light brass-yellow, sometimes inclining to green and gray (Phillips' Mineralogy, Brooke and Miller, 1852).

Yellowish white or of a livid greenish gray (Dufrénoy, Traité de Min., 1856).

Light brass-yellow, inclining to grayish and greenish, often with variegated tarnish (Leonhard, Grundzuge d. Min., 1860).

Pale bronze-yellow or nearly tin-white, with a tinge of yellow or gray (Bristow, Glossary of Min., 1861).

Brass-yellow, inclining to grayish (Tschermak, Min., 1863).

Brass-yellow, but somewhat more gray (Quenstedt, Handb. d. Min., 1863).

Grayish or greenish brass-yellow (Senft, Felsg., 1868).

A much lighter yellow, and more greenish than pyrite (Egleston, Lectures on Min., 1871).

Pale bronze-yellow, livid yellow inclining to green or gray (De Selle, Cours de Min. et Géol., 1878).

Pale bronze-yellow, sometimes inclined to green or gray. (J. D. Dana, System of Min., 1883).

The observations made on my collection, however, have convinced me, that, on a fresh fracture, unaffected by alteration, the true color of marcasite is invariably *grayish white, nearly tin-white.* The yellowish and greenish tinges, commonly presented by its weathered surface or even by the surface of fracture, especially after short exposure, are mere results of incipient decomposition, and should no more be assigned to its normal color than the following stages of iridescence or rusty incrustation. The weather-

ed surfaces of many common minerals, such as hornblende, or chlorite, present similar oxidation-colors ; but even within a crust of compact marcasite, the change is more rapid, and the exact determination of the color on a perfectly fresh fracture may require a somewhat careful inspection under the loup, on account of the filmy greenish, yellowish or iridescent planes which descend through the crust along the surfaces of its radiating plates.

The lustre of marcasite appears to be, in all cases, at least as high as that of pyrite, on a fresh fracture, however soon dulled by the tarnish of incipient oxidation.

A typical variety of stable character seems to have been the favorite decorative material of the Incas or ancient Kings of Peru, being used in rings and amulets, and the larger pieces even polished as mirrors. Under the name, *pierre des Incas*, it has been thus described :[1] "A kind of marcasite having a brilliant lustre, and a colour somewhat approaching to tin-white, when first found, and bearing the same relation to European marcasite, which is generally of a bronze color, that white gold does to ordinary gold."

Marcasite was, together with pyrite, largely used in the last century for ornamental stones, of which it is stated: "The lustre of the polished surface was so brilliant that the stone, although opaque, formed a rough substitute for diamond ; and this lustre was not readily impaired by atmospheric influences.

Much of the old marcasite jewelery is of so pale a color as almost to resemble burnished steel ; such kinds generally belong to the true modern marcasite, sometimes called 'white pyrites'."[2]

"These are what are called health-stones (pierres de santé), because it is supposed that they become tarnished when their wearer becomes sick."[3]

C. Pyrite.

My principal object has been the examination of pyrite, especially in all its crystallized forms, free from gangue-matter. The variation of physical properties with the decreasing density,

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[1] Bristow, Glossary of Min., (1861), 228.

[2] Encyc. Brit., (1883) XV, 532.

[3] Diderot et D'Alembert, Nouveau Dict., (1778), III, 801.

through the series, will be understood from the following preliminary descriptions.

Concretionary nodule. Marsden's Diggings, Galena, Illinois. A concretionary nodule, with finely fibrous structure, especially at its centre, and indications of concentric arrangement.

No. 1. (Fibrous core). Marcasitic pyrite. Very finely fibrous, pale brass-yellow and splendent. See analysis already given. *Decomposition:* dull bronze-colored tarnish, along fissures reaching from the exterior.

No. 2. (Main columnar crust). Marcasitic pyrite. Coarsely fibrous to columnar, pale brass-yellow and splendent. *Decomposition* : tarnished surfaces, and grayish white efflorescence of vitriol in abundance, mainly ferrous sulphate, with a trace or more of ferric sulphate.

No. 3. (Outer crystallized surface). Marcasitic pyrite. At the surface of the nodules, the columns of No. 2 end in a close aggregation of cubes in immediate juxtaposition, each cube capped with a roof-like modification by the pyritohedron (pentagonal dodecahedron). *Decomposition :* dark gray tarnish, with abundant efflorescence of white vitriol in the interstices.

No. 4. Pyrite. Cumberland, England. An aggregate of bright yellow cubical grains, associated with galenite, fluorite, and quartz. A strongly marked platy cleavage, passing into curved scales. Many sharply defined cubes, with the solid angles slightly modified by octahedral planes ; fracture, pale brass-yellow and splendent. Streak, brownish black. *Decomposition :* a beautiful and brilliant iridescent yellow tarnish.

No. 5. Pyrite. Rio Marina, Elba. Brilliant, pale brass-yellow pyritohedrons with striated faces : on a mixture of specular iron and some granular pyrite. *Decomposition :* trace of orange-brown iron-ochre, in cavities of the surface between the crystals.

No. 6. Pyrite. Tevis district, Cochise County, Arizona Territory. Large bright and yellowish grains, with some minute striated cubes, associated with galenite in grayish white quartz. They are reported to contain $40 of gold and silver per ton On fracture, pale brass-yellow and splendent. *Decomposition:* yellow tarnish, bronze-colored on a few particles of pyrite, lying in minute rusty cavities.

No. 7. Pyrite. Adorf, Saxony. Groups of sharply defined cubes, faintly striated ; on drusy rhombohedra of calcite, in cavities of a red hematitic calcareous schist. The crystals are pale brass-yellow and splendent, and possess a very minutely composite scaley structure, sometimes rendering the surface fibrous. Also rare octahedra. *Decomposition :* a bright yellow tarnish on many faces.

No. 8. Pyrite. Alabama, Genesee County, New York. Flattened striated cubes, with sharp edges, and solid angles modified by faces of the octahedron ; pale brass-yellow and splendent on fracture. *Decomposition:* on the outer surface, a brownish black shining enamel of hard compact limonite, a mere film ; but often with soft iron ochre, earthy and orange-yellow, sometimes to the depth of 3 mm.

No. 9. Limonite, pseudomorphous after pyrite. Dutchess County, New York. Sharp, shining striated cubes, unmodified, consisting entirely of limonite. Color reddish brown, with adhering crusts of soft brownish yellow limonite ochre.

No. 10. Pyrite. Gilpin County, Colorado. A light yellowish and brilliant aggregate of small crystals ; in a granular matrix of pyrite, with a little white quartz. The mineral has been found auriferous, $10 per ton. The crystals consist of pyritohedra, tetrakishexahedra, and striated cubes with angles modified by planes of the icositetrahedron ; fresh fracture, pale brass-yellow, splendent, and sub-conchoidal. *Decomposition :* no traces visible in the specimen.

No. 11. Pyrite. Gilpin County, Colorado. A coarser crystalline mass, with geodes of large striated cubes like those of No. 10, but unmodified and splendent like those of No. 95. *Decomposition :* no trace visible in the specimen.

No. 12. Pyrite. Galena, Illinois. A crust upon a nodule of marcasite, already described (See Nos. 23 and 24 of the latter mineral). The coarse fibres terminate, at the exterior of the nodule, in a bright bronze-yellow surface, drusy with splendent crystals of pyrite, iridescent foliated cubes with all their faces curved, arranged in continuous rows, and so producing a kind of striation upon the surface ; within the nodule, the cubes are flat-faced, with octahedral modifications ; with sphalerite in drusy cavities. *Decomposition :* a brass-yellow tarnish ; the

fractured surface of the fibrous material remains splendent and untarnished in a cabinet.

No. 13. Pyrite. Waldenstein, Carinthia. Cubes, slightly striated, pale brass-yellow and splendent; imbedded in brownish black specular hematite. *Decomposition:* no trace visible in the specimen.

No. 14. Pyrite. Waldenstein, Carinthia. A specimen like the preceding, covered with pyritohedra with angles truncated by faces of the octahedron. *Decomposition:* no trace on the outer surfaces, but yellow ochreous films on surfaces of fracture.

No. 15. Pyrite. Chili, South America. Modified cubes and pyritohedra, pale brass-yellow and splendent; associated with silver ores. *Decomposition:* traces of blue and yellowish tarnish seen on the faces of some crystals.

No. 16. Pyrite. Gilpin County, Colorado. Splendent pyritohedra, with traces of striation, very pale brass yellow on fracture; implanted on nearly pure massive pyrite. *Decomposition:* a beautiful iridescence and slightly reddish films on some crystals and on fissures.

No. 17. Pyrite. Pinal County, Arizona Territory. Elongated cubes, slightly striated, pale brass-yellow and splendent. *Decomposition:* no trace visible.

No. 18. Pyrite. Dognatschka, Hungary. Large cubes, occasionally with octahedral modifications upon their solid angles, pale brass yellow, with splendent lustre and mirror-like polish, and sometimes with slight striation; dispersed through a granular veinstone of quartz, pyrite, and hematite. *Decomposition:* a slight iridescence on some planes, or a film of yellow or brown iron oxide, perhaps a mere deposit by vein-waters.

Concretionary nodule. Linden Mine, Wis. A large concretionary nodule, consisting of three materials; a finely fibrous centre, a cellular crust made up of radial grains, and an outer layer of cubes; associated with sphalerite.

No. 19. (Fibrous core). Pyrite. Finely fibrous and radiating from the centre of the nodule, pale brass yellow and splendent, identical in appearance with No. 1. *Decomposition:* a bronze-colored tarnish on ordinary exposure.

No. 20. (Cellular layer). marcasitic pyrite and marcasite.

A granular material of rather cellular structure, consisting of small grains, finely fibrous and radial on cross-fracture, yellowish white, and grayish white, with cavities drusy with microscopic crystals of marcasite. Grains of quartz are occasionally seen enclosed. *Decomposition:* a bronze-colored tarnish, and, in a damp atmosphere, a rapid and abundant efflorescence of white vitriol, ferrous sulphate, which rapidly corrodes the label of the specimen.

No. 21. (Crystallized surface). Pyrite with marcasite. A loose aggregate of cubes of yellowish white pyrite, of composite scaley structure, with drusy cavities in their interstices, lined by the characteristic though minute, deeply furrowed, rhombic twin crystals of marcasite. *Decomposition:* the cubes are mostly stained by a bright orange-colored tarnish, in part yellowish or brownish, and decompose like the inner layer, No. 20, in a damp atmosphere.

No. 22. Pyrite. Central City, Colorado. An aggregate of sharply defined striated cubes, pale brass-yellow and brilliant, with slightly curved faces produced by oscillation with the pyritohedron; attached to crystallized quartz, sphalerite, and siderite. *Decomposition:* an iridescent, bronze-colored tarnish is common, even on fragments after a few months' exposure to dry air; also abundant films of whitish vitriol with strong styptic taste, which was found to contain more ferric than ferrous sulphate.

No. 23. Pyrite. Morrisania, New York City. Very light yellow granules of irregular form; strewn thickly in thin parallel seams through a white crystalline dolomyte. Occasionally an imperfect cube can be detected under the loup, apparently with slight octahedral modifications of its solid angles. Locality, 145th street and St. Ann's Avenue. Two lots of this pyrite were prepared for determination of specific gravity. *Decomposition;* a bright yellow iridescence is general, and in many seams all the granules are deeply stained by or altered into a reddish brown iron-ochre.

No. 24. Turgite, after pyrite. New York City. Small sharply defined, reddish black polished cubes, pseudomorphous in turgite after pyrite; groups upon fissures in an oligoclase-gneiss. The edges of the cubes are often modified by faces of the pyrito-

hedron. A little soft reddish turgite-ochre lies in the interstices of the crystals. Locality, 120th street and 10th avenue.

No. 25. Pyrite. Hazelgreen, Wisconsin. Glittering drusy crusts and films, pale yellowish and brilliant on fracture, lining seams and cavities in a gray limestone. The crystals over these surfaces are all octahedra, in part composite and made up of triangular scales. *Decomposition* : a bright brass-yellow tarnish, partly bronze-colored and iridescent.

No. 26. Pyrite. French Creek. near Pottstown, Chester County, Pennsylvania. Light brass-yellow and splendent cubes, smooth or wit traces of striation produced by oscillation with the octahedron : zonal lines of striæ around some faces. The cubes are mostly intergrown with each other, and with smaller cubes implanted. From a calcite-vein. *Decomposition :* slight iridescent stains on some crystals.

No. 27 Pyrite. Falls of French Creek, Pennsylvania. Brilliant, pale, brass-yellow octahedra, with composite faces, mostly unmodified, but in some crystals with the solid angles bevelled or rounded off by planes of the pyritohedron. Associated with byssolite, in calcite. *Decomposition :* brilliant iridescent tarnish and crusts common, colored deep yellow, blue and red.

No. 28. Pyrite. Negaunee, Mich. A brilliant group of cubes highly modified by the hemi-tetrahexahedron, etc., pale brass-yellow and splendent on fracture, occupying a geode in a quartzose reddish brown hematite. *Decomposition* : a slightly iridescent, blue tarnish.

No. 29. Pyrite. Tuckahoe, Westchester County, New York. Brilliant yellow irregular granules, looking like chalcopyrite but hard ; in white dolomyte-marble. Some grains show the form of cubes, with solid angles modified by the octahedron. *Decomposition* : no trace except a brilliant blue and red iridescent tarnish.

No. 30. Pyrite. Rio Marina, Elba. Bright, pale brass-yellow grains and cubes, striated and with solid angles occasionally modified by the octahedron ; scattered through cellular black hematite. *Decomposition :* no trace visible in the specimen ; but the surfaces of fracture become bronze-colored, on exposure to dry air for several weeks.

No. 31. Pyrite. French Creek, Pennsylvania. Pale brass-yellow brilliant octahedra, often greatly modified and distorted by faces of the pyritohedron; in byssolite and calcite. *Decomposition:* rare traces of iridescence on some crystals.

No. 32. Pyrite. Dutch Girl Mine, Cochise County, Arizona. Glittering yellow grains, associated with galenite, chalcopyrite, quartz, etc.; reported to contain $40 of silver and gold per ton. Some cubes are distinguishable, polished, sometimes striated, with slight modifications of the octahedron and pyritohedron; pale brass-yellow and splendent on fracture. *Decomposition:* a yellow tarnish, partly iridescent or blue.

No. 33. Pyrite. Cornelia Mine, Utah. Pale brass-yellow and splendent cubes, well striated and with the solid angles modified by the octahedron; imbedded in finely granular pyrite and white quartz. *Decomposition:* a slight dulling of lustre on some crystals, with occasional slight iridescence and a blue or red tarnish.

No. 34. Pyrite. Central City, Colorado. Well striated cubes, with faces sometimes curved, and with angles modified by faces of the octahedron and pyritohedron; pale brass-yellow and splendent on fracture. Implanted on drusy quartz. *Decomposition:* a dull bluish iridescent tarnish on many crystals.

No. 35. Pyrite. Rossie, New York. Sharply defined cubes, with indistinct striation, and with solid angles modified by a minute plane of the octahedron, pale brass-yellow and bright on fracture; imbedded in reddish white calcite. *Decomposition:* a slight iridescent yellow tarnish.

No. 36. Pyrite. Hassayampa District, Yavapai County, Arizona. Irregular grains and tiny cubes, sometimes striated and with slight modifications by the pyritohedron; in grayish white quartz. The mineral is pale brass-yellow and splendent, and reported to contain $50 of silver and gold to the ton. *Decomposition:* no trace visible.

No. 37. Pyrite. Fortune Mine, Yavapai County, Arizona. Massive pyrite and brilliant yellow crystals, with galenite in quartz. Strongly striated cubes with modifications of the pyritohedron, and some pyritohedra. The ore is reported to contain $200 of gold and silver per ton. *Decomposition:* a deep yellow tarnish common.

No. 38. Pyrite. Bell Mine, Yavapai County, Arizona. Pale brass-yellow bright grains and tiny crystals, in cavities of a dark mixture of quartz and sphalerite, reported to contain $60 of silver and gold per ton. Polished cubes, sometimes striated or much modified upon the edges by the pyritohedron. *Decomposition* : a bright orange to deep yellow tarnish on some crystals.

No. 39. Pyrite. Bristol, Connecticut. Sharply defined cubes, pale brass-yellow and bright, rarely with octahedral planes or with striation by the pyritohedron upon the solid angles of the largest, and sometimes distorted ; in light gray argillyte. *Decomposition* : a dull yellowish tarnish.

No. 40. Limonite, after pyrite. Bristol, Connecticut. Sharp pseudomorphous hepatic cubes in limonite, reddish brown, shining and striated, largely interpenetrated by grains of a soft, brownish yellow, ochreous gangue.

No. 41. Pyrite. Great Barrington, Massachusetts. Somewhat striated cubes, with curved faces by oscillation with the pyritohedron, and with solid angles slightly modified by the octahedron, and occasional pyritohedra, pale brass-yellow and splendent ; associated with quartz and phlogopite in a blue-gray crystalline dolomyte. *Decomposition* : after long weathering, a bright blue and yellow iridescence to coppery tarnish ; sometimes still bright, when the rock itself is disintegrated, and in part converted to reddish iron-ochre.

No. 42. Pyrite. East Whiteland, Pennsylvania. Sharply defined, flattened cubes like those of No. 8, unmodified, and with traces of striation upon their faces. *Decomposition* : in some cubes, a deep crust of hepatic alteration into compact limonite of blackish brown color.

No. 43. Pyrite. Traversella, Piedmont, Italy. Large striated pyritohedra, and also cubes with modified angles, pale brass-yellow and splendent, both on the surface and on fracture. *Decomposition* : in some crystals, films of brownish yellow iron-oxide on inner surfaces of old fracture.

No. 44. Pyrite. Brockville, Ontario, Canada West. Large unmodified octahedra, and masses with adhering octahedra, pale brass-yellow and splendent on fracture. This material has been found to contain cobalt. *Decomposition* : dull yellow tarnish on

the surface, with spots of brownish yellow iron-ochre; some surfaces are deeply penetrated by gangue-matter and little pockets of limonite-ochre.

No. 45. Limonite, after pyrite. Brockville, Canada. Sharp polished octahedra, with highly composite faces, and with solid angles modified by the pyritohedron; in hepatic reddish brown limonite, pseudomorphous after pyrite; imbedded in a fine grayish limestone.

No. 46 Pyrite. Roxbury, Massachusetts. Strongly striated cubes, with curved faces produced by oscillation with the pyritohedron, pale brass-yellow and splendent on fracture; in groups associated with ochreous siderite. *Decomposition:* a slight tarnish on all faces, and many little spots and films of red iron-oxide.

No. 47. Pyrite. Duluth, Minnesota. Flattened, sharply defined cubes, with occasional octahedral planes upon their solid angles; rather pale brass-yellow and splendent on fracture. The weathered surfaces of the cubes are generally found, after digestion in acid, to be fretted or pitted with octahedral planes. *Decomposition:* a slightly iridescent tarnish, and generally a shining film of brownish black iron-oxide.

No. 48. Pyrite. Thunder Bay, Lake Superior, British America. Yellowish sharply defined cubes, with their solid angles commonly modified by planes of the octahedron, and with faces crossed by short lines of aggregation or cubic cleavage; implanted on white quartz crystals. On fracture, very pale brass-yellow and brilliant. *Decomposition:* dull brownish yellow tarnish, feebly iridescent, on all fac s,

No. 49. Pyrite. Silver Cliffs, Colorado. Dull striated pyritohedra, very pale yellowish white and splendent on fracture, with faces sometimes striated, especially on the sides implanted in the matrix; attached to a finely granular, cellular, blackish matrix of pyrite, with little brownish gray coatings *Decomposition:* a general dull blackish gray tarnish, in part yellow.

No. 50. Pyrite. St. Lawrence County, New York. Sharply defined bright cubes with finely striated faces, rarely slightly curved, pale brass-yellow and splendent on fracture: imbedded in an ash-gray argyllite, with ochreous films over its lamination-seams. *Decomposition:* a reddish orange to orange-yellow tar-

nish, sometimes with slight iridescence on many faces.

No. 51. Pyrite. Smithfield, Rhode Island. Sharply defined glittering, finely striated cubes, with mirror-like polish, and octahedral modifications upon their solid angles, pale brass-yellow, and splendent on fracture; imbedded in greenish white slate. *Decomposition:* iridescent tarnish on some crystals.

No. 52. Pyrite. Colorado. Striated pyritohedra, with angles occasionally modified by the octahedron, pale brass-yellow and splendent on fracture; in groups implanted upon finely granular pyrite and reddish black hematite. *Decomposition:* no trace visible in the specimen.

No. 53. Pyrite. Cornwall, Lebanon County, Pennsylvania. Striated and roughened cubes, highly modified and distorted by planes of the octahedron and pyritohedron, pale brass-yellow and splendent on fracture, imbedded in a black argillaceous schist. *Decomposition:* rather dull tarnish on most faces, with orange to reddish brown films of iron-oxide.

No. 54. Marcasitic pyrite. Guanajuato, Mexico. Mammillary and drusy, hollow, highly iridescent crusts, grayish white and splendent on fracture; implanted on white quartz. The minute crystals are cubes with composite scaley structure, the smaller unmodified, the larger with octahedral planes upon their solid angles; also many cubo-octahedrons. *Decomposition:* a beautiful iridescent and highly brilliant tarnish upon all surfaces, resembling that upon specimens of marcasite from Galena, Ill. (Marcasite, Nos. 16, 20, 25, etc.)

No. 55. Pyrite. Harford County, Maryland. A crust of pyrite on greenish marmolite. The surface exhibits a clustered aggregate of more or less distorted cubes, some even with rhombic faces, their solid angles being occasionally modified by minute faces of the octahedron; pale brass-yellow and splendent on fresh fracture. *Decomposition:* dull yellow tarnish, sometimes with brownish stains.

No. 56. Pyrite. Santa Gertrude Mine, California. Rather dull yellow pyritohedra and cubes, pale brass-yellow and splendent on fracture; mixed with black stony matter. *Decomposition:* dull brownish tarnish common, and sometimes a dull blackish gray film; the fresh fracture soon assumes a bronze-colored tarnish.

No. 57. Pyrite. Lee, Massachusetts. Very minute glittering yellow scales and particles, usually 0.1 to 1.2 mm. in length, scattered in the proportion of three or four to every square centimeter of surface, in fine white dolomytic marble ; associated with particles of tremolite, phlogopite, black and brown tourmaline, rutile and quartz, in the residue left on solution of several pounds of the marble in acid. The crystals are mostly cubes with highly polished faces, rarely showing a few striæ under the microscope ; commonly passing into pyritohedra, and sometimes showing the pyramidal faces of the tetrahexahedron ; pale brass-yellow and splendent on fracture. *Decomposition* : inclining to rapid alteration, partly or completely into reddish brown particles of limonite, with an orange-yellow ochreous halo extending 1 to 5 mm. or more through the marble, around the particle.

No. 58. Marcasitic pyrite. Bay of Chaleur, Lower St. Lawrence, Canada. A dull bronze-colored, round, compact nodule, bright grayish white, faintly yellowish, on fresh fracture. The exterior is covered by large smooth-faced cubes, with angles broadly modified by octahedral faces—approaching cubo-octahedra—and with surfaces marked by scaley composite aggregations. *Decomposition*: the crystals are covered by a dull bronze-colored tarnish ; the cavities between them, by copper-red films of iron-oxide, with a slight efflorescence of white silky needles of sodium-sulphate, with incipient cracks in the nodule ; the fresh fracture, by a rapid yellowish and orange-yellow tarnish, on exposure.

No. 59. Marcasitic pyrite. Dubuque, Iowa. Thin mammillary and botryoidal drusy films, pale brass-yellow and splendent on fracture ; implanted on sphalerite and galenite. The crystals consist of composite scaley octahedra of pyrite, covered by adhering crusts of microscopic flattened coffin-shaped rhombic plates of bronze-colored marcasite, whose presence accounts for the low specific gravity obtained. *Decomposition :* a general dull yellow tarnish.

No. 60. Marcasitic pyrite. Charlemont, Massachusetts. A coarsely granular, glittering yellowish mass, rather loosely aggregated, of grains which are grayish white with spots of orange and yellow tarnish, and splendent on fracture. Nearly every

grain shows a portion of a brilliantly polished crystalline face, rarely of two adjacent, the common form appearing to be a cube more or less modified by or passing into the pyritohedron. Intermixed in different specimens with calcite, garnet, chlorite, chalcopyrite, quartz, limonite, etc. *Decomposition:* a yellow tarnish sometimes occurs, abundant in some specimens, together with particles of reddish iron-ochre.

No. 61. Pyrite. Franconia, New Hampshire. Brilliant, flattened, yellow and sharply defined cubes of scaley structure, with angles modified by the octahedron and pyritohedron, and sometimes striated, pale brass-yellow and splendent on fracture; imbedded in a pearly white, glistening, hydromica-schist. Also a similar specimen from Warren, New Hampshire. *Decomposition:* commonly a beautiful iridescent tarnish. In some specimens, orange-colored iron-oxide surrounds many of the crystals to the distance of 1 or 2 cm., or even stains the entire surface of lamination-seams of the slate with a deep yellowish brown film.

No. 62. Limonite after pyrite. New Hampshire. Sharply defined, striated, unmodified cubes, pseudomorphous after pyrite, sometimes with an unaltered core of pale brass-yellow and splendent pyrite, and a crust of hard reddish black limonite, with shining iridescent surface; imbedded in a quartzose chloritic hydromica-schist.

No. 63. Marcasitic pyrite. Rowe, Massachusetts. A coarse, loosely granular, bright yellow mass, made up of grains which are for the most part imperfect cubes, often highly modified by the pyritohedron, grayish white to yellowish and splendent on fracture. Shining dark blue films, apparently pyrolusite, are common in the interstices. *Decomposition:* spots of yellow and orange tarnish on many grains.

No. 64. Pyrite. Radnor Township, Delaware County, Pennsylvania. Bright, elongated yellow cubes, highly striated and flattened into very thin rectangular scales, with angles sometimes modified by octahedral faces; pale brass-yellow and splendent on fracture; imbedded in a gray slaty limestone. *Decomposition:* a rather dull yellowish tarnish and iridescence common.

No. 65. Marcasitic pyrite. French Creek, Pennsylvania. Bright yellow cubes, with abundant planes of the octahedron and

pyritohedron, oscillation with the two producing a peculiar deep striation and a roughening of the faces by somewhat rounded projections; grayish white and glistening on perfectly fresh fracture; in a greenish gray magnetitic schist. *Decomposition:* blue iridescent tarnish on some crystals; the fracture soon assumes a yellowish tinge.

No. 66 Limonite after pyrite. Texas, Lancaster County, Pennsylvania. Sharply defined, striated cubes of reddish black to reddish brown limonite, often with curved faces, flattened and distorted, sometimes shining with high lustre. Some cubes show hemihedral combinations with the pyritohedron and octahedral modifications of the solid angles; a few perfect octahedra and modified pyritohedra also occur, rarely showing on fracture minute remnants of unaltered pyrite, pale brass-yellow and splendent; on some crystals turgite forms a thin hard exterior coat, with bright reddish streak and reddish brown powder, surrounding and slightly adhering to the internal kernel of limonite.

No. 67. Pyrite. Joplin, Missouri. Brilliant, light yellow cubes, with faces deeply striated and curved by oscillation with the pyritohedron; fracture, very pale brass-yellow, splendent and conchoidal, and streak brownish black; associated with sphalerite, chalcopyrite, and dolomite. Also glittering, pale brass-yellow pyritohedra with smooth faces, intimately mixed with quartz; fracture, very pale yellowish white, splendent and uneven: scattered through a white schist. *Decomposition:* an orange-yellow and blue tarnish.

No. 68. Marcasitic pyrite. King Mountain Mine, Gaston County, North Carolina. Bright yellowish cubes, with very thinly foliated structure, well striated, with faces often a little curved, and occasionally with angles modified by the octahedron and faces further roughened thereby; grayish white, very slightly yellowish, and splendent on fracture; imbedded in a light gray argillaceous schist. *Decomposition:* sometimes iridescence, or a film of orange-colored iron-ochre.

No. 69. Marcasitic pyrite. Schoharie, New York. Rusty spherical nodules, consisting mainly of fibrous and radiating pyrite, very pale yellowish white and sometimes grayish white, with abundant yellow spots and films, on fracture, with an outer

coating of clustered pyritohedra; in clay. *Decomposition:* a copper-red tarnish and reddish brown ochreous film on the surface of the crystals, with interstices occupied by rusty deposits; freshly broken fragments soon assume a yellow tinge and iridescence.

No. 70. Marcasitic pyrite. Weehawken, Hudson County, New Jersey. Glittering yellowish sharp octahedra, with polished faces, and angles slightly bevelled by faces of the pyritohedron, pale brass-yellow and splendent on fracture. One octahedron was found, on fracture, enclosing symmetrically a crystal of chalcopyrite. Associated with diabantite and chalcopyrite, in calcite-veins through diabase. *Decomposition:* a beautiful iridescence rapidly ensuing on exposure, often with crossing lines of blue and red running parallel to the edges of the triangular faces. These colored stripes seem to imply the symmetrical disposition of the intermixed impurity which causes the ready tarnish. The alteration continues and may be seen in all stages of ochreous decomposition, to the hepatic turgite described below.

No. 71. Turgite after pyrite. Weehawken, New Jersey. Dull to shining octahedra, often with sharp edges and retaining the pyritohedral modifications as in No. 70. They consist of black turgite, sometimes reddish black, generally with loose particles of brownish red turgite-ochre attached, or diffused as a colored crust or border immediately around the octahedron, or through the interstices of the calciferous veinstone or adjacent trap. It is significant that the action has almost always gone on irregularly within the grains, so that many show an intermixture of particles of unaltered pyrite and of reddish turgite-ochre. From this unequal progress of the alteration, the surface does not generally retain its perfect lustre, as in hepatic limonite-pseudomorphs elsewhere, but is more or less roughened. On the smooth faces of some crystals, little deposits of soft reddish white material are not uncommon, which, on examination under the microscope, appear to be made up of alternating laminæ of red turgite-ochre and white gypsum; a water solution of the rusty crystals always gives the chemical reaction for calcium-sulphate.

No. 72. Pyrite. Sussex County, New Jersey. Octahedra

with pretty sharp outlines and rough faces, shining in part, covered by limonite; light brass-yellow and brilliant on fracture; imbedded in a feldspathic veinstone. *Decomposition:* a thin shining coating of reddish-brown hepatic limonite.

Nodule, Keyport, New Jersey. A flattened nodule, seamed by radiating cracks, consisting of a fine-grained mass of pyrite, coated by cubes. The crystalline outer crust and granular core were separately examined.

No. 73. (Outer crust). Marcasitic pyrite. Brilliant pale brass-yellow cubes, with scaley structure, and angles modified by planes of the octahedron and sometimes of the pyritohedron; grayish white, bright and uneven on fracture, with many narrow shining columnar faces which are yellowish to iridescent by tarnish. Soft to the file, with brownish black streak, inclining to greenish. *Decomposition:* a very slight yellowish tarnish, rarely iridescent, with delicate incrustations of creamy white gypsum.

No. 74. (Granular core). Marcasitic pyrite. A finely granular cellular mass made up of minute yellowish particles. Under the microscope, these appear as very irregular grains and wrinkled films, mostly yellow and bright, nearly tin-white on fracture: many grains appear striated, apparently flattened cubes with octahedral modifications. *Decomposition:* abundant particles of a white vitriol, ferrous sulphate, throughout the interstices.

No. 75. Marcasitic pyrite. Virginia. A loose ochreous brownish yellow sand, made up of pyrite-grains, 2 to 3 mm. in diameter, readily brightened by digestion in acid. These commonly display the form of imperfect cubes, often hollow, and modified by the octahedron; pale brass-yellow and splendent on fracture. *Decomposition:* a soft brownish yellow limonite-ochre.

No. 76. Marcasitic pyrite. Kelly Mine, Fauquier County, Virginia. Striated cubes, modified by the pyritohedron, very pale yellowish white and splendent on fracture; in a coarse quartz-veinstone. *Decomposition:* much intermixed with and penetrated by turgite-ochre.

No. 77. Marcasitic pyrite. Walton Gold-mine, Louisa County, Virginia. A granular mass, pale brass-yellow and

splendent, and sometimes conchoidal on fracture of some grains. On the edges of the specimen, sharp, brilliant, and unmodified cubes were distinguished. Imbedded in a grayish hydromica-schist. *Decomposition :* a yellow iridescent tarnish.

Nodule. Freiberg, Saxony. A yellowish gray flattened nodule, penetrated by many cracks ; these show that it consists of a finely laminated outer crust of very fine-grained pyrite, coated with glittering cubes, while within appears a finely granular nucleus.

No. 78. (Outer coat). Pyrite. Yellowish cubes, rarely elongated, and sometimes with solid angles modified by small octahedral planes : fracture, pale brass-yellow, splendent and conchoidal. *Decomposition :* a yellowish gray tarnish.

No. 79. (Inner core). Marcasitic pyrite. A fine grained mixture of particles of pyrite and of nearly the same amount of white quartz. *Decomposition :* the interstices of the core are filled by an efflorescence of white vitriol, whose expansion has cracked the nodule, and which is entirely absent from the outer surface.

No. 80. Pyrite. Saddle Island, near Cape Malagash, Tatmag Bay, Nova Scotia. A concretionary spherical nodule, with laminated structure, very finely granular and cryptocrystalline, pale yellowish white and glittering on fracture. This specimen was reported as probably loosened from a sandstone in place. Under a microscope, its material was found to be itself a pyritiferous sandstone, made up of sub-angular to angular grains of gray and white quartz, blood-red ochre, and yellowish white feldspar ; its cement, in much less amount, consisting of pale brass-yellow and splendent pyrite, in delicate strings and films between the grains, forming a bright yellow network over the surface. A few imperfect flattened and striated cubes were also thus distinguished. *Decomposition:* a reddish brown ochreous film colors the outer surface.

No. 81. Pyrite. Eastbourne, England. A concretionary nodule of sausage-shape, showing at one end a core of fine-grained compact pyrite, pale yellowish white and splendent. *Decomposition :* a brownish yellow film of limonite-ochre over the outer surface, with here and there minute projecting cubes of turgite, pseudomorphous after pyrite. Beneath this film is a

thick reddish brown crust of turgite, with red streak, covering the core of pyrite.

No. 82. Pyrite. Schemnitz, Hungary. Somewhat flattened cubo-octahedra, pale brass-yellow and splendent, forming a drusy surface upon a very fine-grained, laminated, yellow layer of marcasitic pyrite, made up of alternately granular and fibrous laminæ, sometimes enclosing grains of radial structure; with white quartz and sphalerite. The specimen, as received, was mis-labelled "marcasite." The specific gravity determination was made on fragments of the entire crust, including about one-fifth volume of crystals and also a very little adhering sphalerite. *Decomposition:* almost no tarnish on the crystals; in the layer beneath, films of white vitriol, mostly ferrous sulphate, occupy the interstices between the fibres.

No. 83. Pyrite. Colorado. Small cryptocrystalline grains, pale brass-yellow and brilliant, made up of scaley aggregations of minute octahedra and cubes with octahedral faces upon their solid angles; imbedded in radiating white barite. *Decomposition:* a slight brownish yellow tarnish on the exterior of the grains.

No. 84. Marcasitic pyrite. Nova Scotia. Small spherical nodules in clay, made up of clustered aggregates of bright striated cubes, modified by minute planes of the octahedron and pyritohedron, and also a few flattened pyritohedra: pale yellowish white and brilliant on fracture. The surface has often been rendered cellular, by the penetration of clay from the matrix. *Decomposition:* minute traces of tarnish on a few faces; the powder becomes bronze-colored, on keeping a few months in a dry atmosphere.

No. 85. Marcasitic pyrite. Silver Valley Mine, Cabarrus County, North Carolina. Brightly yellowish irregular grains, sometimes showing the form of distorted cubes, modified by the pyritohedron, grayish white, nearly silvery white, and splendent on fresh fracture; imbedded in white quartz, with galenite, chalcopyrite and sphalerite. *Decomposition:* a dull yellow tarnish common on many grains, with a few particles of yellow iron-ochre in the interstices.

No. 86. Marcasitic pyrite. Hazelton, Pennsylvania. Yellowish cubes with rather dull lustre, scattered and in groups,

pale brass-yellow and bright on fracture ; attached to black coal-shale. A few are modified by three-faced pyramids of the tetragonal trisoctahedron upon their solid angles. *Decomposition:* slight dull tarnish, iridescent in places.

No. 87. Marcasitic pyrite. Pennsylvania. Bright striated cubes, with octahedral and pyritohedral modifications. Some are imbedded in a blackish brown iron-carbonate. *Decomposition :* a yellow tarnish common.

No. 88. Marcasitic pyrite. Long Creek Mine, Gaston County, North Carolina. Yellowish, coarsely granular and massive; on fresh fracture, grayish white to silvery white and splendent, and sometimes with the slightest yellowish tinge, by incipient decomposition. A few minute crystals were distinguished in cavities, mostly flattened and distorted cubes, modified apparently by the pyritohedron, and a few distorted pyritohedra. *Decomposition :* a bright orange-yellow iridescence common, and some brownish red limonite-ochre in the interstices, with many beautiful films of a bright iridescent blue tarnish.

No. 89. Marcasitic pyrite. Mooresville, Iredell County, North Carolina. A coarse-grained mass of pyrite, on whose borders unmodified cubes can be occasionally distinguished. *Decomposition :* much bright red turgite-ochre, in interstices and on seams.

No. 90. Marcasitic pyrite. Simmond's Mine, Union County, North Carolina. A coarse veinstone, in which unmodified cubes of composite structure occur, pale yellowish white and splendent on fracture. *Decomposition :* a brass-yellow tarnish.

No. 91. Pyrite. Magruder Mine, Georgia. Glittering yellowish scales and particles, scattered through a white porous quartz-rock. Some granules appear to be polished unmodified cubes. *Decomposition :* some red turgite-ochre in the outer surface.

No. 92. Limonite after pyrite. Buncombe County, North Carolina. Sharply defined unmodified cubes of reddish black limonite, hard and shining on fracture, pseudomorphous after pyrite ; imbedded in a grayish white actinolitic steatyte. A reddish brown film covers the smooth faces of the cubes.

No. 93. Mahanoy City, Pennsylvania. Large grains and

cubes, with faces often very finely striated, and cracked up by cubical aggregations, cellular and largely interpenetrated by the matrix, pale yellowish white and bright on fracture; in blackish gray carbonaceous shale. *Decomposition:* rather dull lustre and pale bronze-colored tarnish over most surfaces.

No. 94. Marcasitic pyrite. Liskeard, Cornwall, England. Thickly clustered groups of brilliant cubes of composite structure, forming crusts, pale yellowish white and splendent on fracture; upon gray copper and quartz. *Decomposition:* a beautiful and lustrous orange-yellow tarnish.

No. 95. Marcasitic pyrite. Waynesville, Ohio. Small rounded nodules of irregular form: scattered through a crystalline fossiliferous schistose limestone. These are made up of minute, glittering, rather dull, brownish yellow octahedra, or, in a few nodules, of cubes with octahedral modifications; on fresh fracture, grayish white and splendent, with a slight yellowish tinge, probably due to decomposition. *Decomposition:* iridescent yellow tarnish and dull reddish brown films of iron-oxide.

No. 96. Marcasitic pyrite. Franklin, New Jersey. Sharp, brilliant, brass-yellow, striated pyritohedra, yellowish white and splendent on fracture, imbedded in white feldspar. In coarser powder than that used for the determination in the table, 2.116 gms. of crystals yielded Sp. Gr. =4.642. *Decomposition:* brilliant brass-yellow tarnish, a beautiful blue and red iridescence on some crystals.

No. 97. Pyrite. Colorado. A cluster of dull, pale brass-yellow, striated cubes, implanted and intergrown, with curved faces by oscillation with the pyritohedron, grayish white and splendent on perfectly fresh fracture; sometimes with scattered filmy yellowish spots, due to incipient decomposition; mixed with some blackish stony matter. *Decomposition:* rather dull brass-yellow tarnish, partly iridescent on fracture-surfaces.

No. 98. Marcasitic pyrite. Somerville, Massachusetts. Very sharply defined, glittering yellowish cubes, sometimes distorted or rectangular, rarely striated, occasionally with octahedral planes upon their solid angles, yellowish white and brilliant on fracture; scattered through a gray argillaceous slate. *Decomposition:* a yellow tarnish common on fractured surfaces.

No. 99. Pyrite. Albertville, South Carolina. Bright yellowish flattened cubes, finely striated, pale brass-yellow and brilliant on fracture ; closely associated with quartz in adhering encrusted films and imbedded particles, to which the low density, obtained for this pyrite, may be partly due. *Decomposition :* a slight dull tarnish.

No. 100. Marcasitic pyrite. Roxbury, Massachusetts. Like No. 46, with occasional better development of pyritohedral faces ; associated with sphalerite and siderite. In another specimen, the cubes are strongly striated and pass into distorted forms, closely approaching the pyritohedron ; on some faces there are implanted fine-grained mammillary crusts of glittering drusy marcasite. *Decomposition :* films of yellow to red tarnish on the faces of the pyrite-crystals : a bronze-colored to brownish black tarnish on the marcasite.

No. 101. Pyrite. Monroe, Connecticut. Deeply striated, distorted brilliant cubes of very pale brass-yellow color, with modifications by the pyritohedron ; yellowish white, finely granular, and splendent on fracture, and sometimes enclosing grains of white quartz. The specimen, as received, was mislabelled "pyrrhotine." Under the microscope, the grains are seen to enclose numerous particles of quartz and some reddish prisms looking like topaz. *Decomposition :* a mere film of yellowish tarnish common, iridescent under the loup.

No. 102. Marcasitic pyrite. Pittston, Pennsylvania. Bright, light brass-yellow, striated grains and scales, often with high polish ; fresh fracture uneven, yellowish white, and splendent; as thin coatings and scattered particles in a black carbonaceous iron-stone. Octahedra with brilliantly polished faces and scaley structure, and a few cubes, sometimes striated, with octahedral modifications of their solid angles. *Decomposition :* a slightly iridescent coppery tarnish on some plates.

No. 103. Marcasitic pyrite. Jones' Mine, Pennsylvania. Imperfect octahedra, with brilliantly polished faces, light brass-yellow ; associated with magnetite, calcite, chalcopyrite, etc., from the Coal. *Decomposition :* yellow tarnish common.

No. 104. Marcasitic pyrite. Cumberland, England. Brilliant brass-yellow cubes, with slightly curved faces, and composite and scaley in structure, pale yellowish white and splendent on

fracture; occupying the interstices between crystals of sphalerite. *Decomposition:* slight brass-yellow tarnish.

No. 105. Marcasitic pyrite. Schoharie, New York. Small reddened groups of aggregated crystals, pale yellowish white and granular on fracture, or grayish white with minute yellowish spots; imbedded in clay. The crystals consist of sharp cubes, pyritohedra, and striated cubes with curved faces produced by oscillation between the two forms. *Decomposition:* bright brownish red tarnish, or blue iridescence, on most of the faces.

No. 106. Marcasitic pyrite. Bastrop, Bastrop County, Texas. Dull and pale brass-yellow octahedra, rarely bright, very pale yellowish white and brilliant on fracture; upon black granular crystalline hematite. *Decomposition:* mostly covered by or converted entirely into reddish brown hepatic limonite, which is also scattered over the specimen in rusty crusts.

No. 107. Pyrite. St. Creac, Pyrenees. Feebly shining yellowish cubes, with faces finely striated or roughened and slightly curved; imbedded in a black roofing-slate. Fracture, pale brass-yellow, splendent, often conchoidal. Streak, brownish black. Under a lens, minute black particles are visible in abundance through the grains of pyrite, very distinct under a compound microscope—apparently included particles of slate. The presence of this impurity accounts for the low density, as well as for a peculiar granular and pitted condition of the surface. *Decomposition:* very slight yellowish tarnish, sometimes slightly iridescent

No. 108. Pyrite. Gap Mine, Lancaster County, Pennsylvania. A thin drusy crust, finely fibrous and very minutely cellular, with fine radial crystallization, pale yellowish white and bright on fracture; attached to a similar crust of fibrous millerite. Under a sufficient magnifying power, the drusy surface exhibits minute geodes of microscopic yellow octahedra, sharp and unmodified. *Decomposition:* rapidly disintegrates, even in the dry air of a cabinet, with fibres falling apart; the fresh fracture soon assumes a yellowish iridescence and coppery tarnish, with a minute efflorescence of white vitriol.

No. 109. Marcasitic pyrite. Liskeard, Cornwall, England. Clustered and composite yellowish cubes, sharply defined and brilliant, often with very minute modifications of angles and

edges by the octahedron and pyritohedron ; attached to crystallized quartz. Fresh fracture, tin-white, splendent, and uneven ; its true color requires some care to distinguish, on account of the abundant minute planes of yellow tarnish. Streak, brownish black, perhaps slightly greenish. Under the microscope, the faces of the cubes display a beautiful iridescence, some striation, and a few white films of adhering quartz which have partly contributed to the low density obtained. *Decomposition:* a slight iridescent, pale brass-yellow tarnish, with delicate crimson spots.

No. 110. Pyrite. Ticonderoga, New York. Glittering, light brass-yellow, tiny sharp cubes, commonly with sharp octahedral faces upon their solid angles, forming a drusy surface upon thin flakes of yellow pyrite and quartz. Fracture, yellowish white, in part grayish white, splendent, and conchoidal. The selected grains, used for the determination of density, were afterwards found under the microscope to show adhering films of white quartz, which must have had an influence on the low figure obtained. *Decomposition:* a bright orange-yellow tinge on the surface of many crystals.

No. 111. Marcasitic pyrite. Isle of Sheppey, near London, England. Fragments of a disintegrated fossil plant, *Nipadus ellipticus*, converted mainly into pyrite, with coarse lamination and transverse fibrous texture, evidently produced by woody structure ; from the London Clay. Very fine-grained, light brass-yellow, compact flakes and thin laminæ, yellowish white and glittering on fracture, and marked by fine brownish black lines, the edges of alternating films of carbonaceous matter. Here and there tiny flattened geodes occur, lined by sharp microscopic octahedra of pyrite, in a few cases showing slight modifications of their solid angles. For the specific gravity determination, the material was subjected to careful washing, friction, and elutriation, to remove the soft and light carbon as far as possible, and on this the figures in the table were obtained ; however, some black films still remained enclosed. *Decomposition:* a bronze-yellow tarnish upon all surfaces, and a very abundant white efflorescence of short curved needles of vitriol, mainly ferrous sulphate, but with much ferric sulphate in many crusts.

No. 112. Marcasitic pyrite. London, England. A fine grayish laminated clay, with pyritiferous, shining, bronze-colored films over many planes of lamination. Some of these surfaces are drusy with microscopic octahedra and with spherules roughened by the projecting apices of crystals of pyrite. The surfaces abound in diatomaceous forms of many species (already described by Shrubsole, Kitton, and others), converted into pyrite, bronze-colored without, grayish white and splendent on fresh fracture. From the London Clay. *Decomposition:* this begins with a golden yellow to bronze-colored tarnish, passing into a reddish film, and ending by hepatic alteration into reddish brown turgite-ochre. (See also further description in paper in Jour. N. Y., Micr. Society, 1886, p. 11).

No. 113. Pyrite. Victoria Gold Hill, Colorado. Very fine-grained seams of yellowish auriferous pyrite; pale brass-yellow, splendent, and conchoidal on fracture; imbedded in and intimately mixed with white quartz, particles of which, together with botryoidal opal and purple fluorite in geodes, were distinguished under the microscope in the grains used for determination of density. Imperfect microscopic cubes of pyrite were also seen. *Decomposition:* dull yellow tarnish in part.

No. 114. Pyrite. Anthony's Nose, above Peekskill, New York. A fine-grained yellowish veinstone, whose particles appear grayish white to light brass-yellow, splendent, and conchoidal on fracture. The material is soft to the knife, with gray streak, but not homogeneous. Under a loup, abundant vari-colored specks are seen: pyrite in irregular particles, white quartz, pyrrhotite, chalcopyrite, and scattered prisms of apatite with rounded ends. Under a microscope, imperfect, flattened, and polished cubes of pyrite were distinguished, modified by the pyritohedron and sometimes striated. This ore has been often described as pyrrhotite. *Decomposition:* with the exception of a common yellow and orange tarnish, sometimes iridescent, little alteration is seen in this specimen, a freshly extracted ore, without surface of weathering.

No. 115. Pyrite. Lake Memphremagog, Maine. A fine-granular, compact, but not homogeneous ore, mottled and streaked with brass-yellow and bronze-yellow or gray, soft to the knife with gray streak, and consisting largely of pyrite and

pyrrhotite. Under a microscope, exceedingly fine-grained and splendent, with a few imperfect cubes of pyrite distinguishable, having a platy structure and octahedral modifications of their solid angles. *Decomposition:* no weathered surface upon the specimen, but the fracture reveals, under the microscope, a general blue and red iridescence.

No. 116. Marcasitic pyrite, Mexico. An irregular fragment of an "Aztec mirror," loaned to me for examination by Mr. George F. Kunz; dimensions about 83 by 45 mm., and 15 mm. in thickness, and weight 62.7 grams. The face has been ground smooth and still retains considerable polish; the reverse is roughly convex, apparently by the rubbing off and rounding of the edges of crystalline faces of the pyritohedron. Color of the polished face of the mirror, pale yellowish white; of the reverse, rather dull greenish yellow; of the fresh fracture, grayish white, inclining to yellowish, but not very bright.

Under a loup or low power of the microscope, three materials may be distinguished.

1. Marcasitic pyrite, largely predominating in minute cubes, and also in thin plates (possibly of marcasite), mostly a little less than 0.1 mm. in diameter, and bright tin-white on fracture.

2. Dark brown to black particles, lying in great abundance in the interstices of the preceding crystals, and which seem to consist of iron-oxide, and perhaps carbonaceous matter or other metallic sulphides; this substance has refused to take the polish, and produces a minute dark pitting over the face of the mirror.

3. Over the surface, several minute branching veinlets run, about 0.1 mm. thick, pale brass-yellow and brilliant, evidently of pure pyrite.

The specimen strikes fire with steel and yields a dull reddish black streak or powder. It possesses a special interest, in relation to the Peruvian mirrors of marcasite, the historic *pierre des Incas*, to which reference has already been made.

PYRITE.

No.	Locality.	Sp. Gr. at 15.°5 C.	Weight Taken, in Grams.	Supposed Constitution. Marcasite. Per ct.	Crystallization (by Naumann's notation).	Evidences of Tendency to Decomposition.
3	Galena, Ill.	5.023	1.455	Much	$\infty O \infty \left(\frac{\infty On}{2}\right)$	Grayish tarnish and abundant vitriolescence.
4	Cumberland, Eng.	5.018	5.031	0.	$\infty O \infty.\ O$	Iridescence.
5	Rio Marina, Elba.	5.016	5.002	0.	$\left(\frac{\infty O_2}{2}\right)$	Traces of ochre.
1	Galena, Ill.	5.015	4.433	Much	$\infty O \infty$	Bronze tarnish and abundant vitriolescence.
6	Cochise Co., Ariz.	5.015	3.892	0.	$\infty O \infty$	Traces of tarnish and ochre.
7	Adorf, Saxony.	5.011	2.619	0.	$\infty O \infty$ and O	Slight tarnish.
8	Alabama, N. Y.	5.011	1.856	0.	$\infty O \infty.\ O$	Hepatic coating of limonite.
9	Dutchess County, N. Y.	......	......	0.	$\infty O \infty$	Hepatic limonite-pseudomorphs.
10	Gilpin Co., Col.	5.011	2.761	0.	$\left(\frac{\infty O_2}{2}\right).\ \infty On$, and $\infty O \infty.\ mOm$	No trace.
11	Gilpin Co., Col.	......	......	0.	$\infty O \infty$	No trace.
2	Galena. Ill.	5.010	2.866	Much	$\infty O \infty$	Grayish tarnish and abundant vitriolescence.
12	Galena, Ill.	5.010	3.313	0.	$\infty O \infty$, and $\infty O \infty.\ O$	Slight tarnish.
13	Waldenstein, Carinthia.	5.010	4.490	0.	$\infty O \infty$	No trace.
14	Waldenstein, Carinthia.	......	......	0.	$\left(\frac{\infty O_2}{2}\right).\ O$	Traces of ochre.
15*	Chili, S. A.	5.010	1.443	0.	$\infty O \infty$ and $\left(\frac{\infty O_2}{2}\right)$	Traces of tarnish.

16	Gilpin Co., Col.	5.009	5 044	0 46	$\left(\frac{\infty O_2}{2}\right)$	Traces of tarnish
17	Pinal Co., Ariz.	5.007	5.009	1.37	$\infty O \infty$	No trace.
18	Dognatschka, Hungary	5.006	5 015	1.83	$\infty O \infty$ O	Iridescence.
19*	Linden Mine, Wis.	5.004	1 178	2.74	$\infty O \infty$	Slight tarnish.
22	Central City, Col.	5.003	3.219	3.20	$\infty O \infty$	Decided tarnish & abt. vitriolescence
23*a*	Morrisania, N. Y.	5.003	1.107	3 20	$\infty O \infty$ O	Yellow iridescence.
25	Hazelgreen, Wis.	5.002	1.258	3.66	O	Ready tarnish.
26	French Creek, Penn.	5.001	3.148	4.11	$\infty O \infty$. O	Iridescence.
28*	Negaunee, Mich.	5.000	2 908	4 57	$\infty O \infty. \left(\frac{\infty On}{2}\right)$	Iridescent tarnish.
29	Tuckahoe, N. Y.	4 998	1.335	5 49	$\infty O \infty$ O	Iridescent tarnish
30*	Rio Marina, Elba	4 997	10.884	5.95	$\infty O \infty$. O	Slight tarnish.
31	French Creek, Penn.	4.997	4.495	5.95	O. $\left(\frac{\infty On}{2}\right)$	Traces of iridescence.
32	Dutch Girl Mine, Ariz.	4.996	2.214	6.41	$\infty O \infty$ O $\left(\frac{\infty On}{2}\right)$	Slight tarnish.
33	Cornelia Mine, Utah.	4.995	0 832	6 87	$\infty O \infty$. O	Slight tarnish.
34	Central City, Col.	4.995	5 007	6.87	$\infty O \infty$.O. $\left(\frac{\infty On}{2}\right)$	Occasional dull tarnish.
35	Rossie, N. Y.	4.994	3.367	7.33	$\infty O \infty$ O	Slight tarnish.
36	Yavapai County, Ariz.	4.994	3.809	7.33	$\infty O \infty. \left(\frac{\infty On}{2}\right)$	No trace.
37	Yavapai County, Ariz.	......	......	....	$\infty O \infty. \left(\frac{\infty On}{2}\right)$, and $\left(\frac{\infty O_2}{2}\right)$	Yellow tarnish.
38	Yavapai County, Ariz.	......	......	......	$\infty O \infty$ and $\infty O \infty$. $\left(\frac{\infty On}{2}\right)$	Yellow tarnish
39	Bristol, Conn.	4.993	2.374	7.78	$\infty O \infty$. O	Yellow tarnish.
40	Bristol, Conn.	4.991	6.584	8.70	$\infty O \infty$	Hepatic pseudormorphs.
41	Great Barrington, Mass.	4.989	1.027	9.62	$\infty O \infty$. O. $\left(\frac{\infty On}{2}\right)$, and $\left(\frac{\infty O_2}{2}\right)$	Iridescent tarnish.
42	East Whiteland, Penn.	4.985	8.709	11.47	$\infty O \infty$	Hepatic alteration.
43*	Traversella, Italy.	4.985	5 010	11.47	$\left(\frac{\infty O_2}{2}\right)$, and $\infty O \infty$	Internal ochreous films.

No.	Locality	Sp. Gr. at 15°.5 C.	Weight taken, in Grams	Supposed Constitution. Marcasite. Per ct.	Crystallization (by Naumann's notation).	Evidences of Tendency to Decomposition.
44	Brockville, Canada.	4.985	5.010	11.47	O.	Dull tarnish and ochreous deposits.
45	Brockville, Canada.	......	......	......	O. $\left(\frac{\infty On}{2}\right)$	Hepatic pseudomorphs.
46	Roxbury, Mass.	4 985	6.117	11.47	$\infty O \infty$. $\left(\frac{\infty On}{2}\right)$	Tarnish and ochreous stains.
47	Duluth, Minn.	4.983	2.669	12.38	$\infty O \infty$. O	Tarnish and film of oxide
48	Thunder Bay, L S.	4 980	5.047	13.77	$\infty O \infty$. O	General dull tarnish.
49	Silver Cliffs, Col.	4.980	5.079	13.77	$\left(\frac{\infty O_2}{2}\right)$	General dull tarnish.
50	St. Lawrence Co., N. Y.	4.970	3.761	18 40	$\infty O \infty$.	Tarnish common.
27	French Creek, Penn	4.968	5.009	19.33	O and O. $\left(\frac{\infty O_2}{2}\right)$	Iridescence.
51	Smithfield, R. I.	*4.966	1.093	20 26	$\infty O \infty$. O	Iridescent tarnish.
52*	Colorado.	4.960	3 864	23 04	$\left(\frac{\infty O_2}{2}\right)$. O.	No trace
21	Linden Mine, Wis	4.957	1.055	24 43	$\infty O \infty$	Tarnish and abundant efflorescence.
53	Cornwall, Penn.	4.957	2.142	24.43	$\infty O \infty$. O and $\infty O \infty$. O. $\left(\frac{\infty On}{2}\right)$	Tarnish and reddish films.
54	Guanajuato, Mex	4.954	5.014	25.83	$\infty O \infty$. O, and O. $\infty O \infty$	Brilliant iridescent tarnish.
55	Harford Co., Md.	4.950	5.003	27.70	$\infty O \infty$. O	Dull tarnish and stains.
56	Sta. Gertrude Mine, Cal.	4.950	1.945	27.70	$\left(\frac{\infty O_2}{2}\right)$, and $\infty O \infty$.	General dull tarnish.
57	Lee, Mass	4.949	0.946	28.17	$\infty O \infty$ $\left(\frac{\infty On}{2}\right)$, $\left(\frac{\infty O_2}{2}\right)$ & $\infty O \infty$. ∞On	Alteration to limonite ochre.
58	Bay of Chaleur, Can.	4.948	6.726	28 64	$\infty O \infty$. O.	Dull tarnish and cracking.

23 *b*	Morrisania, N. Y. City	4.946	1.537	29 58	$\infty O \infty \ \ O$	Alteration to ochre.
24	New York City.	......	.....	.....	$\infty O \infty . \left\{ \frac{\infty On}{2} \right\}$	Hepatic alteration to turgite
59	Dubuque, Iowa.	4.944	4 841	30.52	O	General dull tarnish
60	Charlemont, Mass.	4.942	5.625	31.45	$\infty O \infty . \left\{ \frac{\infty On}{2} \right\}$	Tarnish and a little ochre.
61	Franconia, N. H	4 941	0 913	31 92	$\infty O \infty \ \ O \ \left\{ \frac{\infty On}{2} \right\}$	Iridescence to ochreous stains
62	New Hampshire.	......	.....	.....	$\infty O \infty$	Hepatic alteration.
63	Rowe, Mass.	4 940	5 026	32 39	$\infty O \infty . \left\{ \frac{\infty On}{2} \right\}$	None visible.
64	Radnor Towns'p, Penn.	4 940	0.181	32.39	$\infty O \infty \ \ O$	Iridescent tarnish.
65	French Creek. Penn	4 940	5.022	32.39	$\infty O \infty . \ O . \left\{ \frac{\infty On}{2} \right\}$	Iridescent tarnish
66	Texas, Penn.	......	.....	.....	$\infty O \infty , \ O , \left\{ \frac{\infty O_2}{2} \right\}$, etc.	Hepatic limonite
67	Joplin, Mo.	4 936	5 693	34.27	$\infty O \infty . \left\{ \frac{\infty On}{2} \right\}$	Tarnish.
68	King Mt. Mine, N. C	4.927	2.462	38 51	$\infty O \infty \ \ O$	Iridescence and film of ochre.
69	Schoharie, N. Y.	4.926	1 666	38 98	$\left\{ \frac{\infty O_2}{2} \right\}$	Tarnish and ochreous deposits.
70	Weehawken, N. J.	4.919	1 687	42 28	$O . \left\{ \frac{\infty On}{2} \right\}$	Iridescence to hepatic alteration.
72	Sussex County, N. J.	......	.....	.....	O	Iridescence to hepatic alteration.
73	Keyport, N. J	4 918	6.567	42 76	$\infty O \infty . \ O . \left\{ \frac{\infty On}{2} \right\}$	Tarnish.
75	Virginia.	4.917	11.210	43.23	$\infty O \infty . \ O$	Abundant limonite-ochre.
76	Kelly Mine, Va.	......	.....	.....	$\infty O \infty . \left\{ \frac{\infty On}{2} \right\}$	Abundant turgite-ochre.
77	Walton Gold Mine, Va.	......	.....	.....	$\infty O \infty$	Iridescent tarnish.
78	Freiberg, Sax.	4.916	1.949	43.71	$\infty O \infty . \ O$	Tarnish.
80	Saddle Island, N. S.	......	.....	.....	$\infty O \infty$	Brown tarnish.

No.	Locality	Sp. Gr. at 15° 5 C	Weight taken, in Grams	Supposed Constitution Marcasite Per ct	Crystallization. (by Naumann's notation)	Evidences of Tendency to Decomposition.
81	Eastbourne. Eng.	......	......	......	$\infty O \infty$.	Alteration to hepatic turgite.
82*	Schemnitz, Hung	4.913	0 888	45.14	$O.\ \infty O \infty$.	Crystals, rare tarnish; core, vitriol
74	Keyport, N. J.	4.912	6 666	45.61	$\infty O \infty.\ O$.	Abundant vitriolescence.
83	Colorado.	4.910	5.127	46.56	O and $\infty O \infty.\ O$.	Tarnish.
84	Nova Scotia.	4 909	1 077	47 03	$\infty O \infty.\ O.\ \left(\frac{\infty On}{2}\right)$, and $\left(\frac{\infty On}{2}\right)$.	Tarnish.
85	Silver Val. Mine, N. C.	4.909	2.693	47.03	$\infty O \infty.\ \left(\frac{\infty On}{2}\right)$	Tarnish and ochreous particles.
86*	Hazelton, Penn	4 907	1.639	47.98	$\infty O \infty$ and $\infty O \infty.\ m\ O\ m$.	Tarnish.
87	Pennsylvania	......	......	...	$\infty O \infty.\ O.\ \left(\frac{\infty On}{2}\right)$	Tarnish.
88	Long Creek Mine, N C	4.906	4 764	48.45	$\infty O \infty.\ \left(\frac{\infty On}{2}\right)$, and $\left(\frac{\infty On}{2}\right)$	Bright blue iridescence, and some limonite-ochre.
89	Mooresville, N. C	......	......	......	$\infty O \infty$.	Turgite-ochre.
90	Union County, N C.	......	......	..	$\infty O \infty$	Tarnish.
91	Magruder Mine, Ga.	......	......	...	$\infty O \infty$.	Turgite-ochre.
92	Buncombe Co., N C.	......	......	....	$\infty O \infty$	Hepatic limonite.
93*	Mahanoy City, Penn.	4 905	0 742	48 93	$\infty O \infty$.	Dull tarnish.
94	Liskeard, Eng.	4 897	5.025	52 77	$\infty O \infty$	Bright tarnish.
95	Waynesville, Ohio.	4.863	2.625	69 10	O and $\infty O \infty\ O$.	Tarnish and ochreous film.
96	Franklin, N. J	4 856	2 100	72 49	$\left(\frac{\infty O_2}{2}\right)$	Brilliant tarnish.
97	Colorado.	4.849	0 591	75.89	$\infty O \infty\ \left(\frac{\infty On}{2}\right)$	Dull tarnish.

98	Somerville, Mass	4 843	2 941	78 82	$x O x$ and $x O x$ O	Yellow tarnish.
99	Albertville, S C	4.842	1 416	79 31	$x O x$	Dull tarnish.
100	Roxbury, Mass	4.836	5 399	82 24	$x O x. \left(\frac{x\,On}{2} \right)$	Red tarnish.
101	Monroe, Conn	4 819	7.372	90 62	$x O x. \left(\frac{x\,On}{2} \right)$	Film of tarnish.
102	Pittston, Penn	4 817	4.709	91.60	O and $x O x$ O	Slight tarnish.
103	Jones Mine, Penn	...	...	...	O	Slight tarnish.
104	Cumberland, Eng	4 814	5 013	93.06	$x O x$	Slight tarnish.
105	Schoharie, N. Y.	4.809	10 072	95 54	$x O x. \left(\frac{x\,O_2}{2} \right)$	Red tarnish.
106	Bastrop, Texas	4.791	1 477	99	O	Altered to hepatic limonite.
107	St. Creac, Pyrenees	4.780	1.042	...	$x O x$	Slight tarnish
108	Gap Mine, Penn	4 755	1.236	...	O	Rapid tarnish, vitriolescence and disintegration.
109	Liskeard, Eng.	4 744	1.648	99	$x O x$ and $x O x$ O. $\left(\frac{x\,On}{2} \right)$	Slight iridescence
20	Linden Mine, Wis.	4.718	1 099	Much	$x O x$	Bronze tarnish and vitriolescence.
110	Ticonderoga, N. Y	4 713	0.734	...	$x O x$ O	Yellow tinge.
111	Isle of Sheppey, Eng.	4.645	8 856	Much	O	Rapid tarnish, vitriolescence and disintegration.
112	London, Eng	...	...	Much	O	Rapid tarnish and hepatic alteration to turgite-ochre.
79	Freiberg, Sax	4 619	9 256	Much	$x O x$ O	Vitriolescence.
116	Mexico (Aztec mirror)	4 560	162 7	...	$x O x$	Greenish yellow tarnish.
113	Victoria Gold Hill, Col	4 441	5 071	...	$x O x$	Dull tarnish.
114	Peekskill, N. Y.	4 374	6 085	...	$x O x. \left(\frac{x\,On}{2} \right)$	Tarnish.
115	L. Memphremagog, Me	4 195	2 218	...	$x O x$ O	Iridescence.

1. *Density of Normal Pyrite.* In considering the variations of density shown in the third column of the preceding table, the higher numbers, near the head of the column, are open to serious suspicion, from the probable intermixture of galenite, gold or other heavy impurities. The still higher figures 5.158-5.185, obtained by Breithaupt, Kenngott,[1] and Zepharovich, are put aside by Rammelsberg,[2] as too high and he accepts the figure 5.0 as representing the true specific gravity of the pure mineral. The general tendency of the enclosed impurities, marcasite, chalcopyrite, sphalerite, quartz, etc., has been to lower the specific gravity figures, and for this reason we may reject the ten at the bottom of the series. We thus come to the conclusion that the specific gravity of pure normal pyrite must approximate closely to the figure 5.01, which includes the typical and perfectly stable varieties from Colorado, Arizona, Waldenstein and Chili, (Nos. 5, 9, 13, 15, 16, and 17). However, wide variations of density, color, and therefore of constitution, in the crystals of the same locality, appear at many points in the foregoing series. Some prominent instances have been already given to illustrate this local variation, in the Table for the density of Pyrite, in Part I, of this paper; entire reliance cannot be placed in those results, unfortunately, from the method, commonly employed, of determining the specific gravity on whole crystals. The fact of great local variation in density, however, is confirmed by my own figures, a few of which may be tabulated below, with those by other observers from the same localities marked by an asterisk.

Locality.	Specific Gravity.				
Traversella, Italy.	5.097*	5.078*	5.016*	4.985	4.967*
Freiberg, Sax.	5.031*	5 007*	5 001*	4.916	4.619
Elba.	5.027*	5 016	4 997	4.984*	4.976*
Galena, Ill	5.023	5.015	5.010	5.010	
Cumberland, Eng.	5.018	4.814			
Arizona.	5 015	5.007	4.996	4,994	
Gilpin Co , Col.	5.011	5.009	5.003	4.995	
Linden Mine, Wis.	5.004	4.957	4.718		
New York City.	5.003	4 998	4.946		
French Creek, Penn.	5.001	4.997	4.968	4.940	

[1] Sitzungsb. k. Akad. Wiss., Wien, (1854), XII, 286.

[2] Ztschr. d. geol. Ges., (1864), XVI, 267.

2. *Latent constitution of pyrite crystals.* Using therefore the figure 5.01, for the specific gravity of pyrite, in the same way as before, in the formula stated under marcasite, the theoretical percentage proportion of marcasite, present in the specimens of pyrite, has been calculated in the figures of the fifth column of the Table. The twelve specimens (Nos. 94 to 106). which contain 50 per cent. or more of marcasite, are evidently paramorphs after pyrite, two of them, Nos. 97 and 100, corresponding to specimens of pure pyrite, Nos. 10 and 46, from the same localities. In this series, there is even more decided evidence, than in that of marcasite, of the influence of marcasite on the physical properties of the mixture, even to the paling of the color. A similar lowering of density and paling of color, from the suspected presence of marcasite, have already been pointed out by others, *e. g.*, by Köhler, in the crystals of pyrite from Gross Allmerode[1]; the densities of crystals reported from that locality, 4.941 to 4.845, would imply a content of 31.92 to 77.84 per cent. of marcasite, in my view.

At about the specific gravity 4.95, corresponding to a content of 26 or 27 per cent. of marcasite, the crystals begin to show the influence of the contained impurity by a paling of color and marked tendency to decomposition, and this material may be called *marcasitic pyrite.* It is a significant fact that the varieties of the mineral of commercial importance, especially for the manufacture of sulphuric acid, are found near or below this limit, *e. g.*, Nos. 60, 63, etc. The series of specimens of marcasitic pyrite does not become continuous, however, until the specific gravity descends below 4.92, corresponding to a content of 38 per cent. of marcasite. This point therefore seems to mark the danger-limit in cases where a rapid tendency to oxidation becomes objectionable, as with pyrite present in building-stones, roofing-slate, and coal.

It should here be added that, although marcasite appears to be the general element of instability and agent of decomposition, we have evidence in this series of the accessory agency of other sulphides in some cases. The action of chalcopyrite has already been noted, in the case of the cupriferous pyrite of Cornwall,

[1]Pogg. Ann., (1828), XIV., 91—Analysis No. 8 by Rammelsberg, Part I. of this paper, pages 388, 389.

Penn., No. 53. The constant association of chalcopyrite with the octahedra of pyrite at Weehawken, N. J., No. 70, and its occasional enclosure within the latter, have led me to suspect at least its partial connection with the rapid iridescence and ready decay of this pyrite. The arseno-pyrite, indicated by the detection of arsenic in the analysis, already given, of the pyrite from Marsden's Diggings, Galena, Ill., No. 3, at the head of the Table, may very likely have its influence on the quick oxidation and efflorescence of the specimens from that vicinity, Nos. 1, 2 and 3. So too the millerite, attached to the pyrite from the Gap Mine, Penn., No. 108, probably shows that the remarkable instability of the latter mineral may be entirely due to a content of nickel-sulphide.

3. *Relationship of density to crystalline form.* The examination of the series of pyrite-specimens afforded an opportunity to obtain some definite information on this question, mooted by Malaguti and Durocher, so far as regards pyrite. Their views, inclining to the possibility of such a connection, were strongly opposed by V. Zepharovich[1], whose examination, however, appears insufficient, on account of the small number of specimens examined, ten, and the method employed in determining the specific gravity, on crystals unbroken instead of crushed to coarse powder. The figures reported, 5.002 to 5.028, show his crystals to have been pure, but those of Malaguti and Durocher, already cited, 4.402 to 4.973, certainly indicate great impurity. In the sixth column of my table is presented a statement of the carefully identified crystalline forms in each specimen of the series. On the whole, a consideration of these results inclines me to agree in the main with Kenngott's view of the absence of connection between crystalline form and density in pyrite—with the important exception, however, that well defined pyritohedra, with deeply striated faces, invariably possess the highest density, with the yellow color and other properties of the purest forms of pyrite. There also appears some ground to believe that, in the pyrite-crystals of any particular locality, the octahedra are likely to be less rich in pyrite and lower in density than the cubes.

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[1]Kenngott's Min. Notizen, No. 11, (5te Folge), Sitzb. K. Akad. Wiss., Wien, (1858), XI, 392.

Resume. The general theoretical conclusions from this study of the crystals of the iron-pyrites may be now summed up as follows, in regard to the normal types of each mineral :

1. Typical or normal pyrrhotite possesses a specific gravity = 4.6, and a ready tendency to oxidation, only moderated by a notable replacement by, or intermixture with, marcasite or pyrite.

2. Normal marcasite has a tin-white color, a splendent lustre, a density closely approaching 4.80, hardness of 6.5 on most surfaces and of about 6. on the faces of the macrodome (m P ∞), uneven fracture, and a tendency to rapid oxidation, indicated by a greenish yellow, or variegated tarnish, dull or iridescent, soon followed by efflorescence.

3. Normal pyrite has a pale brass-yellow color, splendent lustre, a density of about 5.01, uniform hardness of 6.5, conchoidal fracture, and a strong resistance to oxidation, so slow as to render hepatic alteration common as the final result.

4. The forms of iron pyrites occurring in nature are intimate intermixtures of these three minerals ; rarely of pyrrhotite, however, on account of its ready metasomatic alteration into one or the other of the triad. These common mixtures of marcasite and pyrite may originate by enclosure during crystallization, by alteration, and by displacement, and pass progressively into complete paramorphs, well crystallized after the form of one or the other mineral.

5. The latent constitution of these composite minerals is indicated by a variation in density, exactly proportionate in most cases to the amount of each constituent, and by a similar variation in other physical properties, *e. g.*, hardness, fracture, resistance to decomposition, and even in color, in the case of the paramorphs of marcasitic pyrite.

IV. Practical Applications. We have yet to consider briefly the pertinence of these facts to the choice and treatment of several natural materials, used in the arts, which contain varying mixtures of these pyrites. The distribution of pyrrhotite appears to be so limited, that we may confine our attention

to the occurrence and influence of the other two pyrites. It is highly probable that, in the manufacture of alum, copperas and sometimes that of sulphuric acid, its rapidity, and the volume and cost of the product, may largely depend upon the degree of ready oxidation of the pyrites employed. The comparatively refractory character of certain forms of these minerals, such as the auriferous veinstones of the far West, may yet be an important factor, usually hitherto disregarded[1] in estimates of their future commercial value. The freedom with which a pyritous ore submits to calcination is obviously an element to be considered in the selection of beds of mineral for these purposes. In his discussion of "the characters which best adapt pyrites for the use of acid manufacturers," S. G. Williams includes "readiness to part with the contained sulphur, in which different lots of pyrites show considerable differences."[2] These he attributes to the physical condition of the mineral, to differences of fusibility caused by certain included minerals, and to the retention of sulphur by other included sulphur-compounds, like those of copper. To these causes, it is apparent, should be added the presence and influence of pyrrhotite and marcasite, whose greater inclination to decomposition must materially modify the refractory character of a pyritous ore. The contrary property, resistance to oxidation and disintegration, is equally advantageous in connection with the storing of mined pyritiferous coal and the choice of pyritiferous building-stones and roofing slates.

A. Pyrites in Coal.

An important question has long awaited solution, as to the cause and prevention of that slow oxidation which goes on in masses of mined coal, commonly producing a process of crumbling or "slacking", which may greatly diminish its commercial value, and sometimes endangers the coal by a sensible elevation of temperature, reaching even to spontaneous ignition. The following reference[3] to this has been made by J. P. Kimball: "Among the ordinary circumstances favorable to the weathering

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[1] W. Martin, on Pyrites, Williams, Min. Resources of the U. S., (1883-84), 880.

[2] Applied Geology, (1886), 300.

[3] Trans. Am. Inst. Min. Eng., (1879-80), VIII, 215-217.

of coal after winning is especially its accumulation without ventilation, in stock-piles of great magnitude at mines, points of shipment, or upon the premises of dealers, so as to admit of retention of the heat developed and to promote the process of oxidation under the influence of meteoric water and the heat of the sun. Coals of certain kinds or in certain conditions, exposed in this manner to the weather, are well known to develop heat, even to the point of spontaneous ignition, while other kinds of coals, especially those low in pyrites, may develop the greatest quantity of heat under protection from the weather."

In explanation of these facts, Richters has recently upheld the view that such heat has been developed during the absorption of oxygen, both by its physical condensation within the pores of the coal, and by its chemical combination, resulting in the oxidation of the organic constituents of that substance.

In accordance with this view, it was found that ordinary coals, free from pyrites, experienced the strongest absorption of oxygen when in a dry condition, and could therefore be best protected from a development of heat by preservation in damp places, even with exposure to the atmosphere. On the other hand, the older view attributed the elevation of temperature in loose bodies of coal to the oxidation of its commonly enclosed accessory, pyrites, and, as Kimball points out, with the additional heat produced by the hydration of the sulphuric anhydride, during vitriolization, and by the hydration and further oxidation of the resulting salts. Even with a low average content of pyrites throughout a coal of this kind, the local concentration of this accessory may obviously suffice to produce decomposition and even spontaneous ignition. Accordingly dampness has been found to promote the decomposition of a pyritic coal, and its preservation is best ensured by keeping it in a dry condition and place, with protection from the weather.

There is a difference, however, in facility of decomposition between the two important classes of coals, bituminous and anthracite, which is plainly connected with some peculiarity in their pyritous contents, and Kimball remarks :

"Some of the anomalies observed in coals of transition types, in respect to resistance to weather, are perhaps as much due to differences in their accessory pyrites as to the quantity contained

by them. The occurrence of such differences, however exceptional among bituminous coals, seems adequate to explain the cases on record in which excessively pyritic coal of this class has resisted pyritic decomposition, under the same conditions known in other cases to induce not only energetic pyritic weathering, but spontaneous ignition of the coal. Any doubt as to this point proceeds from the want of specific identification of the pyrites in different coals under such circumstances as to render it a question of importance." This difference in the pyrites is then attributed to the distribution of marcasite as the prevailing form of pyrites in the former class, with its ready yielding to oxidation, and that of pyrite, with its strong resistance to decomposition, in anthracite. This explanation however appears, in view of my results, to be incomplete, inexact, and likely to to lead to serious error. Marcasite, in that form, appears to be a rare accessory in bituminous coals. Their pyrites present themselves in the crystalline form of pyrite, more or less marcasitic in internal constitution, in my view, and so passing into a marcasitic paramorph after pyrite. Even in this impure pyrite other sources of instability lie in its enclosure of finely divided carbonaceous matter, and in the curious physical property of sudden explosion under accumulated strain, during gradual vitriolization. It is therefore as unwise, on the one hand, to trust to the stability of the pyrites in a coal on the ground of its crystallization in the isometric form of pyrite, as it is necessary, on the other, to identify the true character of the mineral, by a careful comparison of its crystalline form, exact density, and degree of reaction in an oxidizing atmosphere, when subjected to experimental trial in one of the ways already described.

B. Pyrites in Building Stone.

On the subject of the influence of pyrites on the durability of a building-stone, the most contradictory observations and statements have been made and are now current; the explanation can be better understood in the light of the present investigation.

On the one hand is the certainly established fact of the common distribution of varieties of pyrites, whose ready oxidation produces offensive discoloration, pitting of the surface, and even in some cases a disintegration of the utmost injury to a building

stone. Of this several instances have been brought to my notice, in masonry within New York City. The gray biotitic gneiss of the island, in large part pyritiferous, has been much used, not only for foundations but for basement-walls up to the water-table, and even for the façade of large public edifices. The rock often contains a notable amount of pyrites, sometimes in the form of polished octahedra of pyrite,[1] or crusts of marcasite, most commonly in the form of scattered grains and flakes of pyrite ; this gneiss has yielded 0.67 per cent. of sulphur on analysis.[2] Where such material has been used without selection, in masonry, and exposed to the weather above the ground-line, an irregular and offensive dirty reddish brown blotching has taken place, after weathering but a few years, *e. g.*, in the retaining-walls of the enclosure at 51st to 52d streets and Madison avenue, the basement of the hospital at 71st street and Madison avenue, etc. In the natural outcrops of the gneiss, the results of oxidation commonly consist of a white vitriol, alum, and hydrated iron-oxide (*e. g.*, at 60th street and 11th avenue, 72d street and Avenue B, etc.), or even of limonite pseudomorphs after pyrite-cubes, which I have found at 120th street and St. Nicholas avenue.

This pyrite is nearly white on fresh fracture, sometimes associated with crystallized marcasite (Marcasite No. 13), in its natural outcrops over the island. An inferior variety of the light buff-colored sandstone, from the Lower Carboniferous of Nova Scotia, was seen in the ashlar of a row of buildings at 87th street, near 2d avenue, spotted with large reddish brown nodules of pyrite in active decomposition, apparently identical with the nodules described under Pyrite Nos. 80 and 84, with Sp. Gr. 4.909. In the dolomitic white marble of the island and vicinity of New York, the pyrite is sometimes quite stable, with Sp. Gr. 5.003 to 4.998 (Pyrite Nos. 23 and 29), and in other beds readily passes into hepatic decomposition having Sp. Gr. 4.946 (Pyrite No. 23*b*). In most of the limestones and marbles of Vermont and of the Housatonic valley through Massachusetts and Connecticut, the pyrite belongs to the quickly perishable variety, and the rock in its vicinity soon becomes

[1] S. C. Bailey, Ann. Lyc. Nat. Hist., N. Y., (1865), VIII, 190.
[2] P. Schweitzer, Jhrsb. Chem., (1878), 1282.

discolored ; a well known example of this is shown in the unfortunate staining of the white marble from Lee, Mass. (Pyrite No. 57, Sp. Gr. 4.949), in the walls of the County Court House in New York City, after weathering less than twenty years. Observations of this character have led to the broad denunciation, in general text-books dealing with the subject, of all pyrites, without discrimination, as the source of injury to building-stones, often in cases due to other causes and defects. The popular distrust of pyritiferous stone thereby generated, has doubtless resulted in the rejection of quantities of valuable and durable building materials.

Dr. Geo. W. Hawes has protested[1] against these unwise and exaggerated statements, on the following ground : "There are other peculiarities of decomposition regarding which too absolute rules have been laid down. Pyrites is considered to be the enemy of the quarryman and constructor, as it decomposes with ease and stains and discolors the rock. But here, too, there are features, which very seriously modify the effect of this decomposing substance. *Pyrites, in sharp, well defined crystals, sometimes decomposes with great difficulty.* If a crystal or grain of pyrites is embodied in soft, porous, light colored sandstones, like those which come from Ohio, its presence will with certainty soon demonstrate itself by the black spot which will form about it in the porous stone, and which will permanently disfigure and mar its beauty. If the same grain of pyrites is situated in a very hard, compact, non-absorbent stone, the constituent minerals of which are not rifted or cracked, this grain of pyrites may decompose and the product be washed away, leaving the stone untarnished." In the passage above italicised, there is implied a recognition of a broader ground of view, one which we may now more clearly see to be founded on an exact discrimination, not only of the crystalline species of the *pyrites* occurring in any stone, but also of its internal constitution, especially its proportion of enclosed or intermixed marcasite. T. Egleston also remarks :[2] "As a general rule when a limestone contains much pyrites it should be discarded,

[1] Report on the the Building Stones of the U. S., Introduction, page 18, Tenth Census of the U. S., (1880), Vol. X.

[2] Trans. Am. Soc Civil Eng., (1886), XV, 670.

but it does not always follow as a necessary consequence that the presence of pyrites in stone is of necessity a disadvantage. As a general rule, the presence of marcasite is. Of the ordinary pyrites some varieties do not decompose, while others do; the presence of such varieties as decompose may disfigure the stone, if in small quantities only, or may cause it to swell and disintegrate if in large quantities. In compact stones its presence has but little influence; in porous ones it is generally objectionable. But no absolute rule should be laid down, for, while as a general thing it is to be avoided, it may be harmless. In general it may be said that the presence of much pyrites makes the stone unfit for use in the exterior of buildings."

In general, therefore, where a perishable form of pyrites is unequally distributed through the stone, in isolated spots and bands, it inevitably produces the well-known deplorable results in injury to color and appearance which might be readily avoided by a previous test of the true nature of the enclosed mineral. In the freestones—the sedimentary sandstones and limestones—the pyrites is almost always liable to decomposition and staining, not merely on account of the porosity of the rock, but chiefly the marcasitic nature of the pyrite: in the crystalline rocks—granytes, tufas, crystalline marbles and dolomytes, etc.,—the nature of the pyrites is uncertain without trial, in some cases readily oxidizable, in others perfectly unobjectionable. It has also been maintained by some architects, and is especially true of the stable varieties of pyrites, that a uniform distribution of any species may be entirely innocuous, or result, after long weathering, only in the production of a slight mellowing of color which may be attractive.

A few instances may be recorded in which the stable form of pyrite has been found in building-stones. In a crystalline dolomyte of great compactness and blue-gray color, occurring at Great Barrington, Mass, I have found the pyrite (No. 41, Sp. Gr. 4·991), after a half century of exposure to the weather in masonry, remaining perfectly bright, and the enclosing rock entirely free from any evidence of corrosion or even discoloration. A similar observation has been made by J. E. Wolff[1] in reference

[1] Report on Building Stones of the U. S., *op. cit*, 290.

to the diabase from Somerville, Mass., in tombstones at Mt. Auburn, in Cambridge, Mass.:

"The diabase tombs have turned a rusty brown, the change apparently occurring in the black minerals (augite, mica, etc.), while the feldspar whitens. It is very noticeable here that grains of pyrite in the stone are generally bright, without patches of rust about them." Other examples of a similar resistance to decomposition, by varieties of each of the three iron-pyrites, have been already mentioned. In pyritiferous building-stones therefore, as in pyritic coal, there now appears to be no difficulty in certainly determining beforehand the character of the contained pyrites, as to stability, by an examination of its physical properties, especially color, fracture, and density, and by experimental trial.

C. PYRITES IN ROOFING-SLATE. The recognition of stability in certain pyrites has not been confined to scientific students; practical men in other fields of observation are familiar with them. Thus the quarrymen in the roofing-slate districts of Vermont and of Wales, and roofers who make use of slates from various regions, are well aware that the grains and crystals of iron pyrites of particular quarries are certain to decompose rapidly and discolor or disintegrate the containing slates, and that such slates must be scrupulously rejected.

It is equally recognized that, in other slates, the pyrite appears indestructible by the weather, and after long exposure upon roofs, remains unattacked, in brilliant hard crystals, with sharp angles, and surfaces untouched by rust. I find this fact also expressed in the following statements of A. Geikie: "Pyrite when free from marcasite yields but slowly to weathering. Hence its cubical crystals may be seen projecting, still fresh, from slates which have been exposed to the atmosphere for several generations."[1] "As a contrast to the universal decay of the marble tombstones, reference may be made to the remarkable durability of the clay slate which has been employed for monumental purposes in Aberdeenshire. It is a fine grained rather soft rock, containing scattered cubes of pyrites, and capable of being readily dressed into thin smooth slabs. A tombstone of

[1] Text Book of Geology, (1882), 85.

this material, erected in the old burying ground at Peterhead, sometime between 1785 and 1790, retains its lettering as sharp and smooth as if only recently incised. Yet the stone is soft enough to be easily cut with the knife.

The cubes of pyrites have resisted weathering so well that a mere thin film of brown hydrous peroxide conceals the brassy undecomposed sulphide from view. The slate is slightly stained yellow round each cube or kernel of pyrites, but its general smooth surface is not affected. The lapse of nearly a century has produced scarcely any change upon this stone, while neighboring tablets of white marble, 100 to 150 years old, present rough granular surfaces and half effaced though still legible inscriptions."[1] Facts such as these show the necessity of the careful and exact determination of the nature of the contained pyrites in all cases, before either the acceptance or rejection of a pyritiferous slate for roofing purposes.

D. Process of Examination of Pyrites in regard to Stability. The process of examination of a specimen of pyrites will be essentially the same, for any of the purposes just indicated. The careful selection of the specimen is of the utmost importance. Finely granular or even massive specimens will will not be sufficient, in consequence of their probable enclosure of impurities and cavities. It is highly desirable to obtain isolated crystals, however minute, carefully separated from their matrix, crushed to a coarse powder, freed from adhering iron-ochre by digestion in a diluted acid, thoroughly washed, and rapidly dried. An examination of the powder, grain by grain, under a loup, still better on the stage of a microscope under a low power objective, should then follow, to ensure the absence of adhering or enclosed impurities and to determine with certainty the true color, fracture, etc.

The determination of the *crystalline form* is first necessary. Even though this should be identified as orthorhombic, that of marcasite, it may not be conclusive as to instability, since we have seen that stable pyritic forms of this mineral exist, probably comprising most of the varieties, in the Marcasite series, of Sp. Gr. 4.98 to 4.88, representing a content of nearly 100 down to 40 per cent. of pyrite. However, the burden of evidence tends

[1] Geological Sketches (1882), 178.

to prove that the isometric forms (cube, octahedron, and pyritohedron), those generally indicating a marcasitic pyrite, are, on the average, richer in pyrite than the orthorhombic and therefore more likely to resist decomposition. The modifications of pyrite seem to have little bearing on this question, with the important exception that sharply defined pyritohedra, with strongly striated faces, are, almost invariably, purely pyritic and stable.

The *color* of the surface, immediately after fracture, is an important indication—if decided brass-yellow, of predominance of pyrite—if of the palest yellowish white or quite tin-white, of richness in marcasite.

A *conchoidal fracture*, if general, is characteristic of pyrite; if uneven or granular, an abundance of marcasite is indicated, and sometimes that of some other intermixed impurity, very frequently quartz—both tending to more rapid oxidation.

Unusual *hardness*, especially shown by the mineral striking fire readily and constantly with steel, indicates the predominance of pyrite, even in crystals of marcasite.

The *sulphurous odor* of the fresh powder or freshly bruised surface, and *greenish streak* appear to be further indications of the presence of marcasite, probably of its abundance. Other intermixed sulphides may contribute the same properties.

The *density* of the mineral, if determined on pure crushed crystals and with sufficient care, may be of the greatest value, in indicating the true constitution of the mixture of pyrite and marcasite, the percentages of each being readily obtained by reference to the tables already given. But a specific gravity determination made upon large unbroken crystals, on too coarse a powder, on massive or granular mineral, or on material not scrupulously examined under the microscope in regard to purity, may be a worthless reliance, only likely to mislead. So far as may be judged from present information, the highest stability can be expected only from samples of crystallized marcasite or pyrite whose specific gravity exceeds 4.99, equivalent to at least 90 per cent. of pyrite; though little danger from decomposition may be expected down to a specific gravity 4.97, equivalent to at least 80 per cent. of pyrite.

Below that amount no stability can be safely relied upon.

These figures, however, can be trusted only when there is reasonable probability, judging from the character of the matrix and associations, of the absence of other impurities, even in microscopic form, such as other metallic sulphides, quartz, iron-ochre, etc., by which the density and stability might be affected.

The natural *weathering* of the specimen may further be an important criterion of its degree of stability in masonry, etc., whenever it can be ascertained that the ochreous decomposition thereby shown has been effected simply by the weather upon some outcrop, during periods insufficient to disintegrate the whole rock, and not by the attack of subterranean solutions percolating from overlying humus, or of the acid corrosive agencies which may affect the material of veins or even merely produce a deceptive deposit of iron-oxide upon unattacked crystals of pyrite. The examination of the pyrites exposed to the weather on the surface of old masonry, slating or the faces of old quarries may be therefore, in many cases, far mor esatisfactory for practical purposes than the study of natural outcrops of the same rock, after ages of unknown experiences. Even in handspecimens, or broken crystals, the long retention of color and lustre, without tarnish or iridescence. for a few weeks or months, on a freshly broken surface of a pyrites under trial, laid out upon a window-sill. may give valuable indications of stability. We thus come to the last and perhaps best means of information—the process of experimental trial of the specimen, side by side with a series of others of known character, by exposure to the oxidizing effect of the fumes of bromine or of fuming nitric acid. Such tests should of course be made on several samples, attention being given to the comparative rapidity of tarnish, the depth of the efflorescent crust and the signs of its internal penetration, the character of the etching upon any remaining nucleus, the evidences and force of any sudden explosion during efflorescence, and the indications of enclosed carbon or other impurity, shown by modifications of the color of the effloresced vitriol.

DESCRIPTION OF PLATES VIII AND IX.

Photomicrographs of etched surfaces of pyrite-crystals by reflected lamp-light (Photogelatine prints).

Plate I.

Fig. 1. Pyrite from Pinal County, Arizona. Mammillated or shagreen-like etching, with pits, magnified 30 diameters.

Fig. 2. Pyrite from Gilpin County, Colorado. Surface pitted in rings, with small mammillations. x 23.

Plate II.

Fig. 3. Pyrite from French Creek, Chester County, Pennsylvania. Larger octahedra projecting above the more deeply etched, fine, crystalline groundmass. x 23.

Fig. 4. Impure pyrite from Mahanoy City, Schuylkill County, Pennsylvania. Minutely fretted cellular surface, without crystals or oolitic structure. x 23.

XI.—*Further Notes on the Osteology of the Shad, (Alosa sapidissima).*

BY FANNY R. M. HITCHCOCK.

Read June 4, 1888.

In a paper[1] on the cartilage plates which are developed in the region of the lateral line of shad, I called attention to the evidence of the concrescence of the anterior body segments, and the following notes are an outline of some of the results obtained while studying the effect of such concrescence on the internal skeleton.

Beginning with the anterior vertebral elements we find that the epipleurals have disappeared, the ribs and epicentrals of the same segments have coalesced, and passing forward are crowded closely together in the region of the exoccipitals and opisthotics ; while the epineurals are similarly crowded against the posterior part of the exoccipitals and the supraoccipital, upon the epiotics and the pterotics, and against the parieto-frontal ridge.

The centra of the corresponding vertebræ have either entirely disappeared, or have united with the basioccipital. The lateral walls of the skull, which are formed by the bones of the ear capsules, are very thick, as is also the supraoccipital.

The parietal bones are wanting, and in place of them is seen on each side of the skull a large foramen which opens directly into the brain cavity. On top of the skull on each side is a deep depression extending laterally into the supraoccipital, epiotic and pterotic bones. The outer lateral and posterior part of the depression deepens, forming a pit which burrows down into the exoccipital bone. In some specimens I could pass a bristle down through this pit into the brain cavity, though in most of the specimens examined there was no connection.

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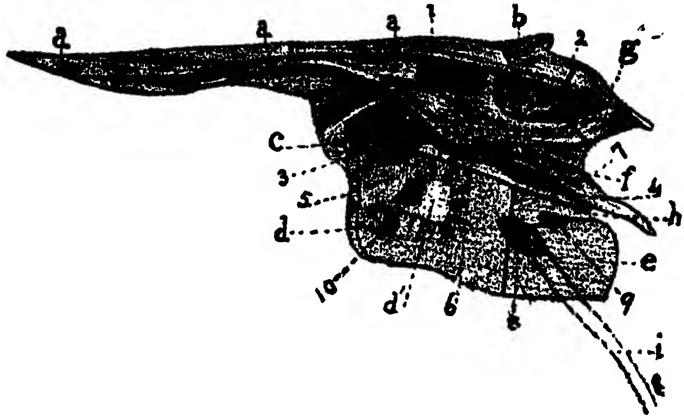
[1] "Preliminary Paper on the Structure of *Alosa Sapidissima*," (abstract), Proc. Amer. Assoc. Adv. Sci. 1887, p. 259.



PORTION OF BRAIN CASE OF ALOSA SAPIDISSIMA.

a. Frontal.
b. Supraoccipital
c. Sphenotic.
d. Prootic.
d' Auditory Capsule.
e. Basioccipital.
f. Pterotic and Opisthotic
g. Epiotic.
h. Exoccipital.
i. Cartilaginous rib-like rod, attached to membraneous wall of cavity in basi-occipital

1. Parietal foramen.
2. Depression reaching down into exoccipital.
3. Facet for anterior head of the hyomandibular.
4. Facet for posterior head of hyomandibular.
5. Foramen leading into anterior auditory chamber.
6. Small foramen leading into same chamber (not described in text).
7. Foramen in pterotic, leading into same chamber.
8. Cavity in basioccipital.
9. Exit for vagus.
10. Exit for seventh nerves.

The hyomandibular articulates with the skull by two heads, widely separated, the posterior being much elongated and in some specimens showing a division into two parts. A small

membrane bone[1] lying between the heads of the hyomandibular, contains a canal which communicates with a foramen lying partly in the sphenotic, and partly in the pterotic and opisthotic.

This foramen opens into a large chamber lying in the prootic, the sphenotic, pterotic, and opisthotic, and opening below into the brain cavity. It contains a large membraneous sac, which receives a branch from the eighth nerve. In the pterotic, just beneath the post-temporal is a large foramen opening into this chamber, and communicating also with a canal in the membrane bones of the pectoral arch. The prootics are co-ossified in the median line and form the anterior part of the floor of the cranium. In the centre of each bone is a large osseous capsule containing a membraneous sac, which receives a branch from the eighth nerve, the branch passing through an oblong slit in the capsule. This slit is the only opening that I could find communicating with the interior of the capsule. This capsule and the chamber described above, with their contents, I shall designate as the *anterior* auditory apparatus.

Covering the capsule nearly, if not entirely, is a plate of cartilage which extends backward on the floor of the cranium to the occipital foramen. It is perforated for the passage of the cranial nerves, and gives off, processes in the shape of cartilaginous rods, which pass into the bones of the ear capsule with the exception of the prootic and sphenotic, with which they have no connection. Similar processes completely surround the occipital foramen.

To the base of the cartilage plate on each side is attached a membraneous sac, containing an otolith. The sac is lodged in a cavity in the basioccipital. The external lateral wall of the cavity is, in most of the specimens, of membrane only, and closely applied to it, on the outer side, is a rib-like rod of cartilage which passes downward and backward, meeting its fellow below

[1] This bone probably represents the squamosal of higher types. The membrane bones of the pectoral arch in the Teleosts, and probably in all fish, may be derived from lateral line scales. The opercular apparatus is probably derived from similar scales.

the dorsal aorta in front of the anterior extremity of the air bladder, with which it is connected.[*]

The cartilaginous processes which pass out from the cartilage plate on the cranial floor, are occasionally continuous with it, but in most cases they articulate with it, and with each other in some instances. Some of the process are double, others are rudimentary. When removed from the bones in which they are imbedded, they present, with some modifications, the form of the membraneous labyrinth of other fish, and in consequence, I have designated them, with the membraneous sac attached to the cartilage plate as the *posterior* auditory apparatus. By careful examination, I am satisfied that the cartilage plate and its processes represent neural arches and epicentrals, and that the crowding together of the anterior body segments has resulted in a coalescence of the anterior vertebral elements with the posterior cranial bones, and a consequent modification of the original auditory apparatus and the formation of a secondary one on the primitive type.

The absorption or non-development of cartilage in the processes above described would give us a membraneous labyrinth of the usual type, and the manner in which such a structure could be formed is thus strongly indicated. Such an origin would give good reason for regarding the auditory apparatus of the Cyclostomata as the most primitive known among vertebrates.

[*] The connection between the air bladder and the auditory apparatus seems to be very primitive in the Shad, and is very interesting, The modification of the auditory apparatus will be dealt with in greater detail in connection with a description of the nervous system now in preparation.

XII.—*On Some New North American Rhynchophora.*

PART I.

BY THOS. L. CASEY.

Read, by Title, April 9th, 1888.

During the three years just past, the writer, whose official duties had previously called him to the Pacific slope of our continent, has utilized his spare moments in the endeavor to amass as complete a set of the Coleoptera of those regions as lay within his power. Many portions of California, Nevada, Arizona and Texas were explored by himself in person, and other regions have contributed through the skillful collecting of Dr. R. W. Shufeldt of the United States Army, near Fort Wingate, New Mexico, and Mr. G. W. Dunn at El Paso, Texas, and Benson, Arizona. He cannot fail also to express his obligations to Mr. W. G. W. Harford and Mr. C. Fuchs, of Oakland, Cal., for many valuable additions.

The total number of species thus brought together and safely transported across the continent, amounts to about three thousand five or six hundred, and their identification and incorporation with the others is a labor of great weight, rendered doubly difficult by the very large proportion of undescribed forms. It has been my special aim to obtain as large a series as possible of every species, for the purpose of studying variation, and these series have already proved one of the greatest aids in estimating the validity of closely allied forms. Species of some genera, which were thought to be very unstable and arbitrary, because of the isolated specimens from different regions which have hitherto been their sole representatives, are, by these fuller series, shown to be far less so, and they seem to indicate that there are many species, differing among themselves in purely external characteristics of form or sculpture, which are as valid as others differing in those modifications of special organs which have been selected as the criteria for specific distinction. Such a genus is Pterostichus, containing a great many apparently valid species which

are remarkably homogeneous among themselves in minor details of structure.

In order to render this mass of material of some avail it is necessary at first to assign names and positions to the undescribed forms, and it is considered preferable to accompany these names with full and detailed descriptions, rather than to promote subsequent confusion by simply naming them in the cabinet. It would certainly be better to give a detailed monograph of every genus receiving the new additions, but in the present case the labor involved would be vastly beyond the power of any single man, and for other reasons it is practically impossible to do so. It is thought, however, by carefully giving references to well-known and allied species that there can be but little confusion introduced.

In systematizing and publishing these novelties special groups will in general be taken up in their entirety, and I have chosen a retrograde movement from Rhynchophora to Carabidæ in preference to the reverse, because there are several genera of Carabidæ which will require monographic revision before any new material can be intelligently incorporated.

The portion dealt with in the present memoir is that comprising the families Rhynchitidæ and Otiorhynchidæ.[1] In the latter the definition of Dr. Le Conte is adopted as being by far the most rational which has ever been proposed. The characterization of the Otiorhynchidæ by the deciduous mandibular piece, converts that which was before a complex of the most discouraging and ambiguous nature, into what is still confessedly a complex, but as clear and plain as sunlight by comparison—at least as far as the North American species are concerned.

Of the fifty-five species of Otiorhynchidæ collected in various regions between Texas and the Pacific coast, but eighteen can be identified with any which have been previously described, the remaining thirty-seven being thus far unrepresented in our catalogues. Considering the vast area and varied conditions of climate, and the fact that the region under consideration is one of the foci of Otiorhynchide life in North America, this proportion is not surprising. The European fauna contains at present

[1] In an appendix subsequently added, the subfamily Sitoninæ is also included.

a vastly greater number of described species than that of North America. If, therefore, we consider the probability that the family is equally well represented in the two continents, it should not be wondered at if every independent collection made in our south-western territories for some time to come consist for the most part of nondescript material.

The family having been recently reclassified and its component parts conveniently described, the task of interpolating these new forms becomes a comparatively easy one.

Several Mexican species before me are not included in the present memoir, as the family will shortly be treated of in the Biologia Centrali-Americana by Dr. Sharp, and any such descriptions would only tend to increase the difficulty of this great undertaking.

NEWPORT, R. I., March 18, 1888.

The following is a list of the new species here described. The measurements in the Rhynchitidæ are taken from the anterior margin of the eyes to the extremity of the body, while throughout the Otiorhynchidæ and Sitoninæ they include the entire body from the tip of the beak in its natural position.

RHYNCHITIDÆ.

Auletes laticollis.

OTIORHYNCHIDÆ.

Epicærus texanus.
sulcatus.
Stamoderes uniformis n. gen.
Ophryastes Shufeldti.
sulcipennis.
Eupagoderes Dunnianus.
Sapotes puncticollis n. gen.
Rhigopsis scutellata.
Amotus longisternus n. gen.
gracilior.
Peritaxia perforata.
Amnesia granulata.
tesselata.
sculptilis.
Nocheles vestitus.
Miloderes setosus n. gen.
Sciopithes significans.
Sciopithes brumalis.
arcuatus.
angustulus.
setosus.
Stenoptochus inconstans n. gen.
Orthoptochus squamiger n. gen.
Peritelodes obtectus n. gen.
Peritelinus variegatus n. gen.
Geoderces puncticollis.
Geodercodes latipennis n. gen.
Aragnomus hispidulus.
Thinoxenus nevadensis.
Panormus setosus n. gen.
Elissa laticeps n. gen.
constricta.
Pseudelissa cinerea n. gen.
Scythropus lateralis.
ferrugineus.
cinereus.
crassicornis.

APPENDIX.

SITONINÆ.

Sitones extrusus.
varians.
margaritosus.
procerus.
occidentalis.
eximius.
montanus.
nebulosus.
alternans.

Sitones sordidus, Lec.
osculans.
prominens.
hispidiceps.
augustulus.
explicitus.
apacheanus.
sparsus.

The species previously described are as follows:—

RHINOMACERIDÆ.

Rhinomacer comptus, Lec.—One specimen. Truckee, Nevada Co., Cal.

RHYNCHITIDÆ.

Rhynchites bicolor, Herbst.—California and Utah.
glastinus, Lec.—Abundant throughout middle California.

OTIORHYNCHIDÆ.

Trigonoscuta pilosa, Mots.—Abundant in the sand dunes near the sea beach of the California coast line. Varies remarkably in size and coloration.

Eupagoderes decipiens, Lec.—Very abundant at Benson, Arizona. Mr. G. W. Dunn.

Rhigopsis effracta, Lec.—Two specimens, California.

Peritaxia rugicollis, Horn.—One specimen, Colorado, Mr. L. E. Ricksecker.

Amnesia granicollis, Lec.—Three specimens, Washington Ter., Mr. L. E. Ricksecker.

Amnesia rauca, Horn.—Four specimens, San Francisco, Cal.

Amnesia sordida, Horn.—One specimen, San Francisco, Cal., Mr. W. G. W. Harford.

Agronus cinerarius, Horn.—Abundant at Lake Tahoe, Cal., in June.

Mylacus saccatus, Lec.—Five specimens, Washington Ter., Mr. L. E. Ricksecker.

Thricolepis inornata, Horn.—Abundant in northern and middle California.

Thricolepis simulator, Horn.—One specimen, San Francisco, Cal., Mr. Dunn.

Tanymecus lacæna, Hbst.—Found in limited number under boards and other similar shelter, behind the sand dunes of the ocean beach at Galveston, Texas, in very early spring. This species differs

greatly from the following, and the abdominal segments are very different in relative proportion. In structure of the mesosternal side-pieces, they should be placed in different divisions, according to the scheme adopted by Dr. Horn.

Tanymecus confertus, Gyll.—Very abundant at Austin, Texas, in June.

Aramigus Fulleri, Horn.—One specimen, San Francisco, Cal., Mr. Harford.

Aphrastus unicolor, Horn.—Extremely abundant at Austin, Texas, in June.

Scythropus californicus, Horn.—Abundant near Sacramento, Cal.

Endiagogus pulcher, Fahrs.—Not very abundant at Houston, Texas, in February, generally under bark.

Endiagogus Rosenschœldi, Fahrs.—Extremely abundant at Houston, Texas, in February, generally in motion on the wooden sidewalks.

RHYNCHITIDÆ.

AULETES Sch.

A. laticollis n. sp.—Three-fourths longer than wide, convex, pale yellowish throughout, except the antennæ and metasternum, which are piceous-black; pubescence sparse, short, semi-erect, whitish in color. *Head* short and robust, much wider than long, broadly, evenly convex, coarsely, not densely, and very feebly punctate toward the sides, impunctate in the middle, feebly convex between the eyes; the latter large, convex and prominent; sides behind them very short, parallel and nearly straight; beak twice as long as the head and scarcely one-third as wide, arcuate, cylindrical, with a very few coarse, feeble punctures at the sides; lateral sulcations moderate, almost impunctate, scarcely at all visible from above; upper surface with an elongate fovea between the antennæ; the latter rather robust, as long as the beak, inserted just beyond the basal third of the latter; club robust; basal joints but slightly thicker than the funicle. *Prothorax* widest at basal third, nearly one-half wider than long; sides strongly arcuate toward base, more strongly convergent and straighter toward the apex; the latter broadly, very feebly arcuate, three-fourths as wide as the base; the latter broadly, evenly, and feebly arcuate; disk evenly and feebly convex, finely, feebly, sparsely, and somewhat unevenly punctate. *Elytra* somewhat dehiscent at apex, two-fifths longer than wide, nearly one-half wider than the prothorax; sides parallel and nearly straight; humeri narrowly rounded; disk convex, feebly impressed along the suture toward base, coarsely, feebly and sparsely punctate. Length, 2.8 mm.

Southern California.

The beak is gradually and extremely feebly dilated from base

to apex; at base it is about two-thirds as wide as the distance between the eyes. The antennal club is slightly paler than the funicle, dark brown, and very densely pubescent.

In the table of Auletes, given by Dr. LeConte (Proc. Am. Phil. Soc., XV., p. 413), this species should be inserted immediately after *ater*, the last joint of the antennal club being about as wide as the tenth, slightly wider than long and obtusely rounded at apex; the tenth joint is fully as long as wide.

OTIORHYNCHIDÆ.

EPICÆRUS Schönh.

The species of this genus may be separated as follows:—

Elytra much longer than wide.
  Antennal club feebly and indistinctly annulate.
    Prothorax widest near the middle; sixth joint of funicle slightly longer than wide, robust, seventh equal in length to the sixth, and but slightly more robust; whitish pubescence of funicle not extending to the club.............. ....**imbricatus**
  Antennal club deeply and distinctly annulate.
    Prothorax widest at base; sixth joint of funicle much longer than wide, rather slender, seventh but slightly longer and thicker; white pubescence of funicle extending to and enveloping the base of the club.................. ....**texanus**
    Prothorax widest before the base; sixth funicular joint small, as long as wide, seventh much longer and thicker; strongly obconical; white pubescence of funicle not extending to the club.... ....:... ....**sulcatus**
Elytra but slightly longer than wide; prothorax widest at base[1] **formidolosus**

The vestiture of the antennal scape varies noticeably. In *imbricatus* and *texanus* it consists of small, rather robust, whitish setæ, which are closely recumbent, and without trace of erect setæ. In *sulcatus*, however, it consists of similar setæ near the base, which become broad and distinct scales toward apex, where also there is an admixture of much longer, erect and darker setæ.

In *sulcatus* the pronotum is strongly, widely, and deeply sulcate in the middle, in *imbricatus* more narrowly and feebly

[1] Horn, Proc. Am. Phil. Soc., XV., p. 20.

so, and in *texanus* very obsoletely, the sulcation being only represented by two elongate impressed foveæ.

E. texanus n. sp.—Form rather robust, pyriform, convex, very densely clothed with pale cinereous and brown scales, indiscriminately mingled on the pronotum, but slightly whiter along the middle, forming indefinite fasciæ on the elytra, the sides and apex usually paler, a pale transverse band at apical declivity most prominent; under surface and legs densely clothed with pale scales. *Head* moderate, slightly conical; front flattened, continued without impression by the beak; the latter robust, slightly longer than the head, a little longer than wide, very feebly dilated toward apex, with a small triangular glabrous area at apex, broadly, feebly impressed along the middle, the impression becoming narrower and stronger toward base; lateral sulcations very short and feeble; preocular impression strong; interocular fovea very small and deep, another larger broadly impressed fovea near the apex behind the glabrous triangle; surface finely, moderately densely punctate, densely squamose, and with fine, very short, semi-erect setæ. *Prothorax* slightly wider than long; sides very feebly convergent and straight from base to apical third, thence more strongly convergent to the apex; base and apex transversely truncate, the former more than one-third wider; disk convex, rendered uneven by very large rather deeply impressed widely and irregularly scattered foveæ, densely squamose, and with minute, sparse, semi-erect, elongate, squamiform setæ. *Elytra* broadly emarginate at base, nearly one-half longer than wide, oval, widest in the middle; sides broadly and evenly arcuate; humeri completely obsolete, very oblique; strongly declivous behind, and feebly inflexed, the inflexed portion of the suture feebly sinuate near the apex when viewed laterally, one-half wider than the prothorax, compressed behind, the sutural region prominent, having rows of large, deeply impressed, widely distant punctures; intervals flat, even, densely squamose, and with very small, elongate, unevenly distributed and rather sparse scales, which are subrecumbent and not at all conspicuous. *Legs* densely squamose, and with fine, short setæ. Length 8.5–10 mm.

Texas (Austin 3).

Varies considerably in the coloration and form of elytral markings. It is very much larger than *formidolosus* Boh.

E. sulcatus n. sp.—Rather robust, convex, pyriform, not very densely clothed with small oval, pale brownish scales, nearly uniform in color, whiter and slightly denser beneath, easily removed from the upper surface; setæ short, sparse, subrecumbent, robust and very inconspicuous. *Head* moderate; beak distinctly longer than the head, one-fourth longer than wide, broadly convex, continued onto the front; the latter slightly flatter; tip of beak broadly, strongly, and angularly

impressed nearly throughout its width; median impressed line broad, short, with the sides parallel, becoming evanescent toward base, more distinctly marked near the apex; lateral impressions short, feeble, parallel; preocular impressions deep, short; interocular puncture small, very deep; eyes rather convex; surface finely, sparsely, and feebly punctate toward the apex of the beak, much more densely so toward base of head.' *Prothorax* slightly wider than long; sides broadly arcuate, convergent for a short distance near the base and a slightly greater distance near the apex; base broadly and very feebly arcuate; apex truncate, much narrower than the base; disk convex, nearly even, with a broad, deep median sulcus slightly interrupted in the middle and a round, deep puncture at the middle of the length and on each side of the median line; surface finely, feebly, and not very densely punctate, more densely squamose at the sides. *Elytra* broadly, very feebly emarginate at base, oval, widest in the middle, four-fifths wider than the prothorax, nearly one-half longer than wide; sides broadly, evenly arcuate; humeri obsolete; disk abruptly declivous behind and slightly inflexed, inflexed portion of suture excessively, broadly, and feebly sinuate when viewed laterally; region of suture near apical declivity slightly more prominent; surface convex, with rows of rather small, deeply impressed, widely and unevenly spaced punctures; intervals nearly flat, even. *Legs* and abdomen squamose, finely and rather sparsely setose. Length 9.5 mm.

New Mexico (Fort Wingate 1).

The type specimen was very kindly communicated by Dr. R. W. Shufeldt.

The species is readily distinguished from *texanus* by many characters besides the shape of the prothorax and the antennal structure. The scales are much sparser in *sulcatus* and are smaller and more elongate-oval. These scales are very distinctly strigose in *texanus*, and excessively, finely, and feebly so in *sulcatus*. The median impressed groove of the beak is quite different in shape in the two species, and in the present one the eyes are distinctly more convex and prominent.

STAMODERES n. gen. (Brachyderini.)

Head hemispherical, not at all impressed behind the eyes; the latter at more than their own length from the prothorax, oval, convex, and very prominent. Beak rather slender, and much longer than the head, nearly twice as long as wide, flattened; sides parallel and straight; alæ slightly dilated. Occiput convex; front flat, not separated from the beak by a well-defined transverse impression. Scrobes lateral, narrow, and deep, beginning at the apex and pursuing a straight course nearly to the middle, then bent suddenly downward, evanescent in a

line with the lower margin of the eyes and at a distance before them nearly equal to their own width. Antennæ robust, shining, setose, attached at anterior third; scape robust, gradually and feebly clavate, attaining the anterior portions of the eyes; funicle robust, nearly one-third longer than the scape, basal joint one-half longer than the second, the latter slightly longer than the third, outer joints short, moniliform, gradually wider, seventh wider than long; club ovoidal, obtusely pointed, moderate. Gular emargination rather deep and narrow. Mentum moderate, slightly longer than wide, subtriangular, widest at apex; sides arcuate; peduncle narrow but rather long; maxillæ almost completely exposed at the sides. Emargination of genæ small, but rather deep. Mandibular scars rounded, rather prominent. Prothorax subcylindrical, without trace of ocular lobes, but having a very feeble line of small white setæ, which are sometimes not at all obvious. Scutellum small but distinct, more densely squamose and slightly tumid. Humeral angles obsolete. Elytra not widely embracing the sides of the body. Legs moderate; femora rather swollen; tibiæ slender, slightly dilated at tip, the anterior not denticulate within, the posterior with a widely separated double edge externally at apex; inner face slightly cavernous; terminal spur small but distinct; tarsi finely and densely pubescent beneath; basal joint elongate; third very strongly dilated, deeply bilobed; fourth slender, elongate; claws moderate, free. Posterior coxæ separated by slightly less than one-half the total width. Metasternum rather long; episterna narrow, well defined; suture distinct. First ventral suture strongly, angularly arcuate for a short distance in the middle; second segment longer than the third and fourth combined.

The obsolete ocular lobes and nearly obsolete fimbriæ together with the other characters above noted, seem to point to a relationship with Barynotus Germ., but there are many reasons also for considering it closely allied to the Amnesia group of Ophryastini, the ocular lobes and fimbriæ simply having become obsolete. In fact, the ocular lobes appear to be of very slight taxonomical value in some portions of the series.

S. uniformis n. sp.—Form elongate-oval, convex, densely clothed throughout above and beneath with small pearly-cinereous scales, with excessively minute, whitish, subrecumbent setæ on the upper surface which form somewhat regular single rows on the elytral intervals, and become longer, finer, and much more dense and erect on the legs and abdomen. *Head* finely, feebly, very densely, and unevenly punctate; beak very broadly and feebly impressed along the middle. *Prothorax* as long as wide; sides nearly parallel, broadly and distinctly arcuate, very feebly constricted just behind the apex; base transversely truncate about one-fourth wider than the apex; the latter feebly sinuate in the

middle; disk very finely, rather evenly, and very densely punctate, without trace of median impressed line. *Elytra* at base as wide as the prothorax, broadly, feebly emarginate, elongate-oval, twice as long as wide, strongly declivous, but not perpendicular behind, acute at apex, slightly less than twice as wide as the prothorax; sides feebly arcuate; humeri very broadly rounded and obsolete; disk convex, finely but distinctly striate; striæ finely and rather closely punctate; intervals feebly convex, equal. Legs and antennæ fuscous; body black. Length 5.5–6.0 mm.

California (Duncan's Mills, Sonoma Co. 2).

The female is much more robust than the male, the prothorax being slightly more transverse and the elytra much more strongly inflated; the above description is taken from the male.

It may be possible that Stamoderes is the same as Mimetes Sch., but in the species here described the beak is much longer than the head, the elytra distinctly wider than the prothorax, and the setæ of the elytral series very small, robust, subrecumbent, and altogether inconspicuous. In the male, there is an extremely feeble, broadly impressed transverse depression at the base of the beak, which is completely obsolete in the female.

OPHRYASTES Schönh.

O. Shufeldti n. sp.—Elongate-oval, very convex, very densely clothed throughout with a cinereous squamose indument, dark brown toward the sides of the pronotum, elytra with feeble mottlings of paler brown. *Head* moderate; front distinctly convex, very broadly and feebly impressed in the middle; beak one-half longer than wide, abruptly dilated at apex, strongly trisulcate; basal transverse impression rather strong, slightly in advance of the eyes; median sulcus narrow, very deeply impressed, just visibly crossing the transverse impression; lateral deep, narrow, ending at the transverse impression; antennæ sparsely setose, densely clothed with a closely adherent crust of very minute elongate scales; first joint of funicle as long as the next two together. *Prothorax* slightly shorter than the head and beak, one-half wider than long, abruptly constricted at the sides near the base and more feebly so at a short distance from the apex; sides most prominent at basal third, rather strongly convergent, very feebly arcuate and not at all notched thence nearly to the apex; base and apex broadly subtruncate, the former broadly, very feebly sinuate in the middle, one-third wider than the apex; disk slightly uneven, very coarsely, deeply, not very densely, and somewhat unevenly punctate; median groove deep, narrow, and entire. *Elytra* oval, slightly less than one-half longer than wide, nearly one-half wider than the prothorax, widest before the middle, perpendicular behind,

not at all inflexed at apex; sides broadly and distinctly arcuate; humeri broadly rounded, obsolete; base broadly angularly emarginate, more noticeably so in the middle; disk very broadly and strongly convex, rather narrowly and strongly striate; striæ impressed, scarcely one-half as wide as the intervals, with rows of large impressed approximate punctures which are not very well defined; intervals broadly feebly convex, with very minute sparse irregularly scattered setæ. *Legs* pale cinereous throughout. Length (to end of beak) 15.0 mm.

New Mexico (Fort Wingate 1).

A single representative of this very fine species was discovered and kindly communicated by Captain R. W. Shufeldt, Med. Dept. U. S. A., in honor of whom it is named.

It is readily distinguished from *tuberosus* and *latirostris* of LeConte by the much less transverse prothorax.

O. sulcipennis n. sp.—Form oblong, densely clothed throughout with a squamose dark brown indument, paler beneath and on the legs; alternate intervals of elytra slightly paler by certain reflections. *Head* moderate; beak very much longer than the head, and, at apex, nearly as wide, fully one-half longer than wide, abruptly strongly dilated at apex, strongly trisulcate; sulci abruptly ending at the very deep and strongly marked transverse basal impression; middle sulcus very broad and deep, shallower anteriorly, becoming gradually narrower and deeper toward base, obsolete in apical two-fifths: lateral only present in basal half, narrow, deep, becoming slightly broader from apex to base; front convex, flattened above in the middle; antennæ with dense piceous indument; first joint of funicle slightly longer than the next two together. *Prothorax* nearly twice as wide as long, widest at posterior third where the sides are very strongly rounded and prominent, thence strongly convergent and almost straight nearly to the apex, then abruptly constricted, strongly constricted near the base behind the lateral prominences; sides very minutely and unevenly notched at middle; base transverse, truncate, one-third wider than the apex; the latter broadly arcuate; disk broadly convex, slightly uneven, being broadly impressed anteriorly and laterally, coarsely and indefinitely ruguloso-punctate; median groove moderate, not well defined. *Elytra* oblong, rather acutely rounded behind from above, declivous posteriorly, but not perpendicular, slightly wider at apical third; sides nearly straight; humeri very broadly rounded; base transversely truncate; scutellum slightly prominent, triangular, wider than long, black, finely rugulose, dull; disk flattened above, strongly convex at the sides, less than one-half longer than wide, very slightly wider than the prothorax, deeply sulcate; sulci with very large, rather close, feebly defined impressed punctures; intervals but slightly wider than the sulci, very strongly convex, with small, slender, scattered setæ. Length 13.0 mm.

New Mexico (Fort Wingate 1). Dr. R. W. Shufeldt.

This species differs from *latirostris* Lec. in its deeply sulcate elytra. Its facies is very different from that of *Shufeldti*. In both, the postocular lobes are broad and strong, with very long dense fimbriæ.

In *Shufeldti* the second ventral segment is about one-half longer than the third, while in *sulcipennis* it is just perceptibly longer than the third.

There is no species in the cabinet of LeConte which is at all similar to either of those above described.

EUPAGODERES Horn.

E. Dunnianus n. sp.—Moderately robust, convex, very densely clothed throughout with white scales, sometimes feebly and unevenly mottled with gray; scales overlapping on the elytra, closely crowded and polygonal on the head and prothorax; setæ very short, sparse, and erect anteriorly; longer, much denser, subrecumbent, and squamiform on the elytral intervals, absent from the striæ, where there are excessively minute, erect white hairs which are very distant. *Head* short, strongly transverse, evenly, feebly convex longitudinally, and slightly more strongly so in a transverse line between the eyes; beak one-half longer than wide, slightly narrower than the head, feebly, abruptly dilated at apex; surface broadly and very feebly convex, declivous at apex where there is a small triangular emargination, between the antennæ a small deep elongate fovea, and, on each side above, from near the base of each antenna to slightly beyond basal third, a straight, feebly-impressed channel; surface of head and beak finely, evenly, and sparsely punctate; antennæ inserted at apical third; scape short, robust, gradually clavate, two-thirds as long at the funicle; first joint of the latter as long as the next two together, outer joints slightly and gradually wider, seventh close to the club throughout its width, nearly one-half wider than long; club small, ovoidal, pointed; scarcely wider than the apex of the scape, not distinctly annulate. *Prothorax* distinctly wider than long; sides parallel, almost evenly and moderately arcuate; disk coarsely, sparsely, and somewhat unevenly punctate, with a subapical median elongate fovea. *Elytra* evenly oval, truncate at base, two and one-half times longer and three-fourths wider than the prothorax; striæ very fine, very finely, feebly, and remotely punctate. Length 9.5–11.5 mm.

Texas (El Paso 7). Mr. G. W. Dunn.

Allied to *decipiens* Lec., but differs in its more transverse prothorax and very fine, scarcely punctate elytral striæ. In this species the males and females differ but slightly in form,

whereas in *decipiens* they are strikingly different, the males being very much the more slender.

SAPOTES n. gen. (Ophryastini).

Beak about as long as the head, trisulcate; scrobes narrow, deep, beginning near the apex, passing rapidly beneath, vanishing slightly below and before the eyes; the latter broader than long, subacute beneath, partially concealed in repose by the ocular lobes. Antennæ short; scape a little shorter than the funicle, barely attaining the eyes, gradually, feebly clavate; funicle seven-jointed, first joint as long as the next two together, second nearly twice as long as the third, joints three to six equal, subquadrate, seventh a little wider, transverse, rather close to the club; the latter ovoidal, pointed, rather small, finely pubescent. Prothorax without lateral tuberosities; ocular lobes well developed, devoid of fimbriæ. Scutellum small, triangular, distinct. Tenth elytral stria distinct in basal third. First abdominal segment much longer than the metasternum, nearly as long as the next three together, separated from the second by a very feebly arcuate, deeply impressed suture; second nearly as long as the third and fourth together. Tarsi rather robust; first three joints short, setose with the tips spinose beneath; third slightly wider than the second, bilobed; fourth nearly as long as the first three together; claws long, divergent. Cotyloid surface of the posterior tibiæ semi-cavernous, having a long outer and a short inner line of short, very robust spinules; spurs obsolete.

The mentum is small, subquadrate, very deeply seated, and has near the apex two deep setigerous punctures. The entire body, including the tarsi and antennæ, except the antennal club, is covered with a very thick, dense indument of a scale-like nature, the scales not overlapping, but densely and polygonally crowded.

On comparing this genus with Ophryastes, it is seen to differ in its non-fimbriate ocular lobes, more dilated third tarsal joint, and evenly rounded sides of the prothorax. From Eupagoderes it also differs in the first character, and in its much longer fourth tarsal joint and second ventral segment.

S. puncticollis n. sp.—Form elongate-oval, subparallel, convex; prothorax whitish, two lateral vittæ dark brown; elytra whitish, unevenly clouded with darker, especially toward the suture; under surface whitish; femora brown, except the apices which are white. *Head* distinctly wider than the beak; front broadly and evenly convex, separated from the beak by a very feeble transverse impression; beak

flat, dilated at apex; surface with three narrow, deep, and abrupt canaliculations, the median beginning at the middle and terminating at the transverse impression, the lateral beginning at the basal third, continuing parallel with the median to the transverse impression and then turning abruptly outward and downward to the anterior margin of the eye; apex truncate and feebly trisinuate; surface of head and beak finely punctate, each puncture bearing a very small seta. *Prothorax* cylindrical, one-third wider than long, slightly wider than the head; sides very feebly, nearly evenly arcuate; base and apex transversely truncate, nearly equal; surface very coarsely, deeply, and densely punctate, the fine setæ arising from fine punctures irregularly scattered over the convex interspaces of the large foveæ. Scutellum distinct, white. *Elytra* elongate-oval, nearly three-fourths longer than wide; sides very feebly arcuate; humeri broadly rounded; disk one-half wider than the prothorax, at base equal to the latter, broadly sinuate; basal margin elevated; striæ feebly impressed, coarsely, deeply, but not very closely punctate; intervals nearly flat, each with a row of long stiff spinous setæ. *Legs* and abdomen with fine sparse setæ. Length 4.0–4.6 mm.

Texas (El Paso 2). Mr. G. W. Dunn.

The anterior tibiæ have a few small denticles along the inner edge toward apex.

RHIGOPSIS Lec.

R. scutellata n. sp.—Form oval, slightly depressed above, densely clothed throughout with very large, closely adherent, and slightly overlapping scales, which are white and blackish intermingled, the former greatly predominating, not at all concealed by exudation. *Head* and beak distinctly longer than the prothorax; beak deeply trisulcate, the middle sulcus continuing uninterrupted to the base of the head, the lateral abruptly ending at the front and attenuated anteriorly; prominences over the eyes moderate, the front between them scarcely at all concave. *Prothorax* one-third wider than long, widest at anterior fourth where the sides are distinctly arcuate, thence slightly convergent and nearly straight to the base; the latter broadly arcuate and about as wide as the apex; the latter truncate between the advanced and prominent ocular lobes; disk convex transversely, arcuately impressed near the apex, with a broad, deeply impressed median line, interrupted near the middle, the basal fovea being the longer; surface coarsely ruguloso-foveolate. Scutellum rounded, convex, distinct. *Elytra* oblong, less than one-half longer than wide, slightly produced at apex; the latter truncate; sides parallel and slightly arcuate; humeri oblique, slightly prominent posteriorly; disk three-fourths wider than the prothorax; each elytron with three prominent ridges, the two inner terminating in abrupt and moderate

tubercles, the first at the apex, the second at the sides and at posterior fourth; intervals very coarsely, moderately, and irregularly ruguloso-foveolate, with small, robust very sparse recumbent setæ, under surface and legs densely squamose and with short, white subrecumbent setæ. Length 6.5 mm.

California (Los Angeles Co. 2).

Differs from *effracta* in three very important points of structure. The front in *effracta* is distinctly concave, the median sulcus interrupted by the concavity and with the prominences over the eyes much more marked. The scutellum in that species is very minute, elongate, acute and indistinct. The general surface sculpture in *effracta* is very much coarser, and the tubercles of the elytra almost doubly prominent. The size of *scutellata* is decidedly greater than that of *effracta*.

The scales in this genus are very large, nearly circular and are not at all strigose, but feebly and finely granulose.

AMOTUS n. gen. (Ophryastini).

This genus belongs among the Strangaliodes in the immediate neighborhood of Mimetes.

Beak rather slender, twice as long as wide, much narrower than the head from which it is separated by a strong transverse impression, truncate at apex; alæ rather large, dilated; scrobes very deep, strongly arcuate, passing beneath at a distance before the eyes nearly equal to their own length; antennæ rather robust, finely and not densely pubescent, the funicle with sparse, erect setæ in addition; scape robust, gradually clavate, extending to the middle of the eye, shorter than the funicle; first joint of the latter much longer than the second, outer joints slightly wider, seventh obconical, scarcely as long as wide; club oval, finely pubescent, three-jointed; mandibular scar not prominent. Metasternum long; episterna very narrow; suture very distinct and deeply impressed. First ventral suture very strongly sinuate in the middle half; second segment long, in the middle nearly twice as long as the next two together. Anterior tibiæ not distinctly denticulate; posterior with obsolete terminal spur, the cotyloid surfaces cavernous; claws robust, divergent.

The ocular lobes are obsolete and in one species are replaced by a row of exceedingly short, scarcely visible setæ, and in the other by a shorter row of longer vibrissæ. The eyes are rounded, rather large, very convex, prominent and coarsely granulated.

It may be possible that this is the genus identified by Dr.

Horn as Mimetes Sch. According to the description given by Lacordaire (Gen. Col. VI., p. 39), I cannot, however, regard it as such. In this description the beak is stated to be as long as, and rather narrower than the head and flat above, while in the present genus, it is very much longer and narrower than the head and is impressed along the middle. The eyes are stated to be small in Mimetes and the elytra not wider than the prothorax, which is not the case in either of the species before me. The very minute setæ which are present on the elytra are subrecumbent, and the term "poils redressés" could not be appropriately applied. It is also possible that the species described below as *A. gracilior* is the same as that identified as *Mimetes setulosus* by Dr. Horn.

The two species described below may be distinguished as follows:—

Ocular vibrissæ extremely short and inconspicuous; median impressed groove of beak very feeble and only present toward base... **longisternus.**

Ocular vibrissæ longer and more conspicuous; beak strongly and broadly impressed in the middle throughout its length..**gracilior.**

In both these species the elytral intervals are broadly and feebly convex, the alternate ones slightly more strongly so, especially toward apex, near which point the ridges of the third and seventh intervals unite and thence continue to the apex as a single ridge. This character will serve to distinguish them from *seniculus* Horn, in which the elytral intervals are flat.

A. longisternus n. sp.—Form oblong-oval, rather depressed above, densely clothed with dark cinereous scales which are rounded and polygonally crowded, closely adherent and covered with a shining glaze, darker on the head and prothorax. *Head* moderate; occiput very strongly convex, finely, very densely punctate, scarcely squamose except toward tip of beak where the scales are of a cupreous lustre; eyes very prominent. *Prothorax* slightly wider than long, subcylindrical; sides strongly and nearly evenly arcuate; abruptly and deeply constricted at the sides just behind the apex, the constriction extending almost across the disk; base and apex subtruncate, the former very slightly the wider; disk convex, perfectly even, very finely, densely, and feebly granulose. Scutellum small. *Elytra* oblong, nearly one-half longer than wide, three-fourths wider than the prothorax, abruptly acute behind; sides nearly straight and parallel in the middle; humeri broadly rounded; base broadly emarginate; disk more strongly convex at the sides, very finely and feebly striate, the striæ with very minute,

distant, and indistinct punctures; intervals alternately slightly more strongly convex, each with a single row of fine, semi-erect, widely distant setæ. *Abdomen* more sparsely covered with scales which are plumose, also with excessively short, sparse setæ. *Legs* finely setose, densely squamose; tarsi densely pubescent above and much more densely so beneath. Length 6.8 mm.

California (Los Angeles Co. 1).

Easily distinguished from the next by its larger size, more robust, depressed form, and finer, longer dorsal setæ.

A. gracilior n. sp.—Form elongate-oval, convex, densely clothed with pale, uniform, cinereous scales which are densely crowded, glazed and graniform above, plumose beneath. *Head* small, moderately convex; beak sparsely squamose; surface feebly granulose or finely rugulosely punctate; eyes prominent, very coarsely granulated, large. *Prothorax* cylindrical, fully as long as wide, evenly and not strongly rounded at the sides, constricted just behind the anterior margin, the groove becoming very broad and shallow at the middle of the disk; base and apex truncate, the former slightly the wider; disk convex, even, not punctate, densely granulato-squamose. Scutellum small but distinct, ogival. *Elytra* elongate-oval, but slightly less than twice as long as wide, acute at apex, more than one-half wider than the prothorax; sides broadly arcuate; humeri broadly rounded; disk convex, finely striate, the striæ with very fine distant punctures; alternate intervals more strongly convex, all with a single row of short, subrecumbent white setæ which are rather distant. *Abdomen* with fine, erect, sparse setæ, much longer than those of the upper surface, densely squamose. *Legs* setose, densely squamose; tarsi setose above, densely pubescent beneath. Length 5.5 mm.

California (Los Angeles Co. 2).

The scales of the under surface are rather large and are beautifully plumose around their entire circumference.

This species is easily distinguished from the preceding, in addition to the characters given above, by the longer setæ of the abdomen and the rather shorter second ventral segment, the first suture being less strongly arcuate in the middle.

PERITAXIA Horn.

In this genus the ocular lobes are of less than usual importance, and in several other minor characters it is more or less heterogeneous.

P. perforata n. sp.—Form elongate-oval, convex, black throughout, except the antennæ which are piceous-black and rufous toward the

base of the scape; integuments above shining, sparsely squamose, the scales always distinctly separated, rounded, thick, covered with a varnish-like coating; pubescence long, erect, rather dense, distributed without trace of order on the elytra. *Head* wider than long, conical, evenly, not strongly convex, coarsely but not very densely punctate, separated from the beak by a deep, abrupt, transversely and posteriorly arcuate groove, which, at the sides, is well in advance of the eyes; the latter large, feebly convex; beak very slightly longer than the head, distinctly longer than wide, very feebly dilated at apex, broadly, feebly, and evenly convex, coarsely, very densely punctate toward base, feebly and very sparsely so toward apex, where it is feebly and transversely impressed in a posteriorly arcuate line inclosing an angulate elevation at the middle of the apical edge; scrobes lateral, though slightly visible from above, deep, evenly arcuate and descending, becoming evanescent just below and very near the apical margin of the eye; antennæ rather slender; scape slender, strongly clavate, nearly attaining the middle of the eye, scarcely two-thirds as long as the funicle; the latter slender, all the joints distinctly elongate, first two not perceptibly thicker than the third, first three uniformly and very gradually decreasing in length, seventh obconical; club elongate, slender, pointed, annulate, one-half as long as the scape. *Prothorax* distinctly wider than long, scarcely perceptibly narrowed from base to apex; sides almost evenly and moderately arcuate; base and apex truncate; disk evenly convex, coarsely, very densely, and deeply punctate; punctures somewhat longitudinally coalescent; interspaces sometimes with fine, distant punctures; scales three or four times as sparse as those of the elytra. *Elytra* two and one-half times longer, and more than one-third wider, than prothorax, nearly twice as long as wide, oval, rather acutely rounded behind from above; humeri dentiform; sides nearly straight from near the base to just behind the middle; disk convex, slightly prominent behind on the suture; sutural line slightly inflexed toward apex; surface with very feeble striæ, which contain large, very deep, perforate punctures; the latter distant in the series by slightly more than their own diameters; intervals flat, and about twice as wide as the punctures. *Legs* moderate; femora robust; anterior tibiæ not denticulate within; first joint of tarsi distinctly longer than wide. *Abdomen* sparsely squamose, sparsely and finely setose; first suture feebly arcuate in the middle half; second segment slightly longer than the next two together. Length 7.5 mm.

Texas (exact locality not specified 1).

The ocular lobes are totally obsolete, but the fringe of vibrissæ is well marked and conspicuous.

This species differs from *hispida* Horn in its feebler elytral striæ, and much coarser and deeper strial punctures.

AMNESIA Horn.

The species of this genus are rather numerous, and inhabit the regions between the Rocky Mountains and the Pacific Ocean. Of the six species before me, but three appear to have been previously described. These six species are easily divided into three distinct groups as follows :—

Terminal spur of posterior tibiæ long, stout, and prominent; body oval, rather robust, at least in the female.

I. Outer joints of funicle longer than wide; elytral pubescence very short, sparse, and inconspicuous.................. **granicollis**

II. Outer joints of funicle small, robust, moniliform, not longer than wide; pubescence of elytra long and conspicuous.

Pronotum in the middle finely and densely granulose, not at all squamose.................... .... **granulata**

Pronotum coarsely and very unevenly granulose, the granules bearing a few small, broadly oval scales, adherent to their upper surfaces by reason of a varnish-like coating ... . **rauca**

Pronotum covered rather sparsely with scales which are free, or very nearly so, not covered with a varnish-like exudation.

Pronotal scales short, oval, finely and strongly strigose. **sordida**

Pronotal scales very long and slender, more conspicuous, not perceptibly strigose............................... **tesselata**

III. Terminal spur of posterior tibiæ very small, nearly obsolete; body narrow and elongate; outer joints of funicle much longer than wide.

Antennal scape very long and slender, slightly passing the posterior margin of the eye; elytral pubescence very short and inconspicuous; anterior tibiæ very strongly denticulate within throughout the length.................................... ...**sculptilis**

In all of these species the first ventral suture is more or less distinctly arcuate in the middle, sometimes rather broadly, and occasionally very narrowly so. The second segment varies in length, being generally slightly longer than the third and fourth combined, especially in group II., but sometimes slightly shorter than the latter, as seen in groups I. and III. In both these latter groups the elytral intervals are alternately more convex, very conspicuously so near the apical declivity, while in group II. the surface is generally even, or with the alternate intervals, in very exceptional cases, very slightly more prominent. The ocular lobe also varies conspicuously in prominence. Through *sculptilis* the genus, as here considered, seems to approach very near to Dyslobus Lec., and as it is seen to be rather hetero-

geneous in a great many characters—although preserving a certain facies which is unmistakable—its separation from Dyslobus may be premature.

The use of the terminal spur of the posterior tibiæ in the separation of the genera of the Strangaliodes is rather misleading, except when employed in a relative sense, because this spur is generally present in at least a rudimentary state; in the genus before us it appears to lose all significance, as it would evidently be unwarrantable to separate the species with less developed spur from those in which it is more prominent, because of their great similarity in the more important characters and their great variability in others of less moment.

The humeri of such species as *granicollis* are dentate when viewed vertically, this appearance being the vertical projection of the obliquely elevated basal margin of the elytra. In *granicollis* the second ventral segment is transversely tumid or subcarinate in the middle throughout its width. I have not observed this character in any other species.

A. granulata n. sp.—Form elongate-ovoidal, slightly widest at posterior third of elytra, convex, blackish-castaneous, finely and very densely granulose throughout the pronotum and elytra, the granules each with a very minute, obsolete non-setigerous puncture, the long, rather dense, erect black setæ arising from the interspaces, not regularly arranged on the elytra; along the sides of the pronotum the granulations are slightly pale, and along the flanks of the elytra there are three or four small spots of whitish tint. *Head* moderate, hemispherical; beak distinctly longer and much narrower, broadly, transversely, and very evenly convex, without trace of medial carina, transversely and strongly impressed at base, about one-half longer than wide, dilated at tip, granulations becoming small and more squamiform at the base of the head, very dense throughout; antennæ rather robust; scape scarcely attaining the posterior margin of the eye, feebly clavate, shorter than the funicle; first joint of the latter much longer than the second, outer joints short, moniliform, seventh slightly longer than the sixth; club robust, oval, pointed, very feebly annulated. *Prothorax* nearly one-fourth wider than long; sides broadly arcuate, nearly even throughout the length; base and apex truncate, the former distinctly wider; ocular lobes rather small, but distinct; disk broadly, evenly convex, narrowly and deeply canaliculate in the middle, from apical to basal fifth. *Elytra* about two-thirds longer than wide, about one-third wider than the prothorax, broadly emarginate at base; sides very feebly arcuate; humeri obsolete, very broadly rounded, the sides not at all dentate, but forming an unrounded acute angle with the emargina-

tion of the base; disk convex, finely, rather deeply striate; striæ finely, deeply, but not very closely punctate; intervals flat, even, equal. *Legs* rather densely granulose, each granule being formed by a thick rounded scale, covered with a shining coating, rather densely setose. *Abdomen* rather strongly and densely punctate. Length 6.5 mm.

California (Humboldt and Siskiyou Cos. 2).

Not closely allied to any other described species, but belongs in the neighborhood of *rauca*.

A. rauca Horn—Proc. Am. Phil. Soc., XV., p. 51.—Four specimens from the neighborhood of San Francisco appear to coincide well with the original description of this species. The type specimen was undoubtedly a male; in the female the elytra are decidedly more inflated and the form more robust.

A. tesselata n. sp.—Form robust, oval, convex, moderately densely clothed with pale brownish fulvous scales; prothorax with arcuate interrupted lateral vittæ and a very narrow median line black, alternate intervals of elytra with darker and paler spots giving a tesselated appearance, more evident on the third interval behind; setæ rather dense, moderate or rather short, pale yellowish, irregularly arranged on the elytra, more prominent on the pronotum. *Head* hemispherical; beak much longer than the head, fully one-half longer than wide, dilated at apex, flattened, obsoletely subcarinate in the middle toward base; basal transverse impression strong; surface finely, deeply, very densely, and subrugulosely punctate; beak not at all squamose, setose; head with squamulose hairs; antennæ rather robust; scape short, just attaining the middle of the eye, gradually and rather strongly clavate, distinctly shorter than the funicle; basal joint of the latter slightly longer than the second. *Prothorax* nearly one-third wider than long; sides broadly, evenly, and rather feebly arcuate; base truncate, much wider than the apex; the latter feebly sinuate in the middle; disk broadly convex, with a narrow, deeply impressed median canaliculation from the middle nearly to the apex, finely, deeply, densely, and subrugulosely punctate, not granulate. *Elytra* convex, oval, less than one-half longer than wide, three-fourths wider than the prothorax; sides broadly, distinctly arcuate; humeri very broadly rounded, obsolete externally, basal angle right, not rounded; base broadly emarginate; disk finely striate; striæ feebly impressed, with small, rounded, rather distant punctures, each of which bears a very minute, subrecumbent, pale seta; intervals broadly, feebly convex. *Legs* very sparsely squamose, with long erect setæ. *Abdomen* rather finely, deeply, and moderately densely punctate; first suture arcuate, and impressed for a very short distance in the middle. Length 5.5 mm.

California (San Francisco 3).

The above description is drawn from the female. The male is more slender with the elytra less inflated.

This is a very distinct species, not closely allied to any other; it should be placed near *sordida* and *decidua*, from both of which it differs in its rugulosely punctate and not granulate pronotum. The ocular lobes are very broad and short.

A. sculptilis n. sp.—Elongate, convex, castaneous; legs throughout pale rufous, antennæ slightly darker; rather sparsely clothed with very small rounded free scales, reddish in color, with bright cupreous golden reflection. *Head* hemispherical; beak nearly twice as long as the head, and twice as long as wide, basal impression rather strong, with the surface subcylindrical, broadly and feebly tumid or subcarinate toward base, the tumid portion shining and not punctate, gradually strongly dilated toward tip, where there is a median elongate puncture between the bases of the antennæ; surface coarsely, deeply, densely, and subrugulosely punctate, with scattered setæ towards apex, sparse rounded scales between the eyes, and denser elongate squamiform hairs at the base; antennæ very long and slender; first two joints of funicle equal in length, seventh much longer and thicker than the sixth, obconical, much longer than wide; club small, elongate-oval, pointed, not as long as the three preceding joints together. *Prothorax* as long as wide; sides parallel and very feebly arcuate, except near the base and apex where they are more rapidly convergent and arcuate; base and apex broadly and extremely feebly arcuate, the former slightly the wider; disk broadly, evenly convex, coarsely, deeply, and rather densely ruguloso-granulate, the granules with large setigerous punctures; surface with minute round scales, evenly and widely scattered, and with short, robust, erect setæ; median impressed channel only present for a short distance near the apical margin; ocular lobes broad, moderate in length, densely fimbriate. Scutellum very short, broadly angulate. *Elytra* elongate, three-fourths longer than wide, widest near the middle, where they are about one-fourth wider than the prothorax; sides very broadly arcuate; humeri very broadly rounded, obsolete externally, basal angle slightly produced and acute; base broadly emarginate; disk abruptly declivous at posteriorf ourth, the declivous portion straight along the suture and not perpendicular, having rows of large, round, very deeply impressed punctures, distant by two to three times their own width, each bearing from its internal anterior edge an extremely minute pale seta; intervals alternately nearly flat and convex, the convexities becoming much more prominent toward the apical declivity, rather densely clothed with small, round, separated scales, and short, very robust, erect blackish setæ not regularly arranged. *Abdomen* rather feebly ruguloso-punctate, sparsely, finely pubescent, with a few scattered squamiform hairs near the sides, impressed in the middle of the base; first suture feebly arcuate for a very short distance in the

middle. *Legs* very sparsely squamose, more densely setose, long; tibiæ long and slender, the anterior strongly denticulate along the inner edge. Length 8.5 mm.

California (Anderson Valley, Mendocino Co. 1).

In the type, which is probably a male, the anterior tibiæ are strongly bent inward near the apex. The middle tibiæ are slightly shorter than either the anterior or posterior, and both the middle and posterior have a few small denticles along the inner edge. The posterior tibiæ are nearly straight, and not abruptly, but at apex, as is related of the male of Dyslobus by Dr. Horn (Proc. Am. Phil. Soc., XV., p. 41). This species in fact appears to unite the characters of Dyslobus and Amnesia, and perhaps indicates the propriety of uniting them under the name Dyslobus.

The present specimen was found in the sandy bed of the Navarro River, under dried leaves, in the latter part of June. It is probably one of the species peculiar to the great redwood belt.

NOCHELES Horn.

N. vestitus n. sp.—Form rather elongate-oval, convex: very densely clothed throughout the body, legs and antennal scape with rather large, widely overlapping scales, which are dark-brown in color, and very deeply and coarsely striate. *Head* very short and broad, deeply inserted; beak three times as long as the head, more than twice as long as wide: sides parallel, straight; alæ rather large and dilated; surface nearly flat, extremely, broadly, and feebly impressed transversely at base, having in the middle near the apex a minute, elongate fovea, sparsely, finely punctate, with prominent setiform erect scales, tip with a small angular glabrous area; scrobes beginning at the apex, deep and cavernous, feebly arcuate, rapidly becoming evanescent before the eyes, and at a distance from them more than equal to their own width; antennæ rather robust; scape gradually enlarged from base to apex, passing just beyond the anterior margin of the eye, distinctly shorter than the funicle; the latter not squamose, but with robust setæ, fine pubescence and a roughly pitted surface, two basal joints elongate, subequal, remainder short, seventh slightly wider than long; eyes rather large and finely granulate, feebly convex, wider than long, slightly pointed beneath. *Prothorax* scarcely as long as the head and beak, slightly wider than long, widest slightly before the middle; sides distinctly and broadly arcuate, constricted at the sides just behind the apex; ocular lobes moderate in size, very strong, with a row of very short fimbriæ, almost entirely beneath the eyes, the latter free; base broadly arcuate: apex truncate between the ocular lobes, distinctly narrower than the base;

disk convex, finely subrugulose, densely punctate, with a deeply impressed median line, densely squamose and with prominent suberect setiform scales. Scutellum minute, triangular, evident. *Elytra* oblong-oval, abruptly declivous, and slightly inflexed at apex, one-half longer than wide, two-thirds wider than the prothorax; sides feebly arcuate; humeri narrowly rounded, slightly prominent; base broadly emarginate; disk convex, coarsely and rather strongly striate, striæ nearly as wide as the intervals, equal, having rows of moderate rather deep punctures which are separated by about three times their own widths, and each closed by a broad whitish scale; intervals convex, each with a single prominent line of long, erect setiform scales. *Legs* rather robust; anterior tibiæ finely denticulate within; cotyloid surfaces oblique; terminal spur of posterior small but distinct. First ventral segment more convex; suture arcuate in middle three-fourths; second segment much longer than the next two together. Length 6.5 mm.

Nevada (Washoe Co.).

The mentum almost entirely fills the gular opening, entirely covering the maxillæ; it is moderate in size, as wide as long, subquadrate with the angles rounded, concave behind, not pedunculate. The mandibular scar is rather large and prominent, subtriangular. The apical cavernous portions of the antennal scrobes are quite as open when viewed vertically as laterally, in this respect seeming to form a transition toward Phyxelis.

This species, which differs from *æqualis* Horn in color and in its deeper median thoracic line and elytral striæ, was found in abundance in the bed of the Truckee River at Reno, under stones in very early spring.

The setiform scales of the upper surface are very prominent, and of a bright brownish-yellow color.

MILODERES n. gen. (Ophryastini).

This name is proposed for a very singular species possessing the following assemblage of characters :—

Beak slightly longer and narrower than the head, very feebly narrowed toward apex ; alæ very feebly dilated ; surface of head and beak continuously convex, without trace of transverse impression. Eyes rather small, slightly convex, coarsely granulated, oval, slightly wider than long. Antennæ rather slender, subapical ; scape slender at base, abruptly clavate, attaining the middle of the eyes ; funicle slender, seven-jointed, basal joint as long as the next two combined, outer joints shorter, moniliform, seventh slightly wider than long, oval, rather close to the club ; the latter elongate, rather narrow, pointed, finely

pubescent; remainder coarsely and sparsely setose, shining. Scrobes beginning on the sides at the apex, gradually descending in a rather strong arc, and ending near the lower margin of the eye, rather deep and narrow. Mentum large, flat, not deeply placed, filling the entire gular cavity, wider than long, broadly rounded at apex. Genæ with a rather small and feeble mandibular emargination. Mandibular scar small, not prominent, strongly transverse. Prothorax with small but distinct ocular lobes, which are distinctly fimbriate. Scutellum not distinct. Elytra inflated. Legs rather short and robust; anterior tibiæ not denticulate within; articular surfaces very oblique, scaly, those of the posterior not cavernous, the latter not mucronate at tip. Posterior coxæ very widely separated, at the sides of the body, small. Abdomen rather short; first suture arcuate for a short distance in the middle; second segment slightly longer than the next two together. Tarsi spinose beneath, with the third joint distinctly wider than the second, bilobed; the fourth is as long as the remainder combined; basal joint scarcely longer than the second. Claws rather long, free.

If we regard this genus as belonging to the first division of Dr. Horn, its place is probably near Cimbocera, but the mesosternal side-pieces are completely divided, the episternum entirely separated from the elytra by the epimeron, and the metasternal episternum is produced inward slightly at the apex, which characters would prompt us to place it in the second division, where, however, it apparently does not belong. In form it greatly resembles *Trigonoscuta pilosa*, and in the latter species the mesosternal side-pieces are also divided as in the second division.

M. setosus n. sp.—Form oval, rather robust, convex, densely covered throughout with a thick indument, composed of very large luteous closely adherent scales, which are very convex and polygonally crowded on the head, prothorax, and abdomen, but flatter and more dense on the elytra; color of body and legs black; entire surface bristling with very long, erect, pale setæ, not regularly arranged on the elytra. *Beak* slightly longer than the head, feebly attenuate, flat, with a very indistinct median fovea, slightly produced in the middle at apex, the lobe separated posteriorly by a posteriorly angulate suture. *Prothorax* widest slightly before the middle; sides strongly arcuate, convergent toward base, just perceptibly constricted at the sides immediately behind the apical margin, one-half wider than long, much wider than the head, not perceptibly punctate; base truncate; apex broadly, feebly arcuate, equal to the base. *Elytra* inflated, widest at basal fourth; sides thence feebly convergent and very feebly arcuate, abruptly, broadly rounded behind; posterior declivity perpendicular; humeri obsolete; disk convex, one-half wider than the prothorax, one-

fourth longer than wide, having rows of coarse, deep, very distant punctures; intervals unevenly and rather coarsely punctured. Length 5.5 mm.

California (Kern Co. 1).

The punctures of the elytral intervals are not as large as those of the rows, but are so unevenly distributed as to almost completely destroy the appearance of serial arrangement in the latter, which appearance is increased by the great distance of the serial punctures.

SCIOPITHES Horn.

The species of this genus are numerous in California; those here described may be mutually separated as follows:—

Antennal scape passing distinctly beyond the anterior margin of the prothorax.
- Sixth joint of funicle distinctly shorter than the seventh.
  - Outer joints of funicle slender; seventh joint in the female much longer than either the fourth, fifth, or sixth, equal to the third, and in the male very nearly as long.
    - Elytral scales smaller, very minutely and feebly striate; setæ generally finer and piceous; surface markings strong and distinct.. ....**significans.**
    - Elytral scales coarse, especially near the suture, very coarsely and deeply striate; setæ more robust and squamose, pale; surface markings very indistinct and suffused.... **brumalis.**
  - Outer joints of funicle more robust: seventh but slightly longer than the fifth or sixth, scarcely longer, but more robust than the fourth.......................................**arcuatus.**
- Sixth and seventh joints of funicle both elongate, equal. **angustulus.**

Antennal scape just attaining the anterior margin of the prothorax. **setosus.**

These characters appear to be but slightly affected by sex. The shallow fovea mentioned by Dr. Horn is visible in *significans*, *brumalis*, and *arcuatus* as a very broad, excessively feeble impression on each side of the upper portion of the pronotum and just behind the middle, but is entirely obsolete in *angustulus* and *setosus*. *S. obscurus* Horn may possibly be included in the above table, but the description of this species will apply more or less satisfactorily to several; I, however, believe it to be unrepresented in the material before me, as the posterior band of the

elytra is mentioned as being "very irregularly sinuous." This expression will scarcely apply to *significans* and *arcuatus*—the only two which can be reasonably selected to compare with *obscurus*—as in these species the transverse band is but very slightly uneven.

In form these species are all more or less cylindrical anteriorly, with the elytra strongly inflated, the integuments very densely squamose, and the claws rather approximate.

S. significans n. sp.—Sides of the prothorax and elytra pale luteous, the pale tint crossing the elytra posteriorly in a broadly, feebly sinuate band edged anteriorly with piceous; remainder of the upper surface very dark reddish-brown; median pale line of pronotum exceedingly narrow and feeble and only visible toward base; abdomen very sparsely squamose toward apex, rather densely so toward base, sparsely clothed with erect pale hairs. *Head* and beak very slightly longer than the prothorax, gradually narrowed from base to apex; eyes large, convex, at nearly their own length from the base; front depressed, with an elongate canaliculate puncture between the eyes; transverse impression very feeble; beak as long as wide, very feebly and obsoletely carinate along the middle, scrobes very short, deep, cavernous, convergent, vanishing at their own length from the eyes; apex between them triangularly impressed and almost glabrous, the bottom more declivous at the apex; antennæ long and slender; scape feebly arcuate, setose, very sparsely squamose above; funicle slender, not more robust toward apex, basal joint slightly less than one-half longer than the second, first four joints decreasing uniformly and rapidly in length. *Prothorax* cylindrical, slightly wider than long, broadly constricted in the apical third; sides feebly arcuate in the middle; disk rather coarsely, deeply, but not densely punctate, sparsely and finely setose; setæ subrecumbent. *Elytra* strongly inflated, more than twice as wide as the prothorax, nearly one-half longer than wide, very acute at apex; sides arcuate; disk convex, tumid along the suture behind, very finely and feebly striate; striæ finely, feebly, and very distantly punctate; intervals very feebly convex, each with a widely distant row of small subrecumbent setæ. *Legs* slightly more sparsely squamose, setose. *Abdomen* feebly convex; first suture feebly arcuate in the middle; second segment one-half longer than the third; third and fourth subequal. Length 4.0-6.0 mm.

California (Mendocino Co. 2; Humboldt Co. 12).

In this species the central parts of the disk are very deep in color, the outer portions pale and the lines of demarcation very strong and distinct; the setæ assumed the color of the surrounding scales. The claws appear to be very slightly connate at base,

but the two short fixed spurs of the posterior tibiæ are visible; they are very short, approximate, and truncate.

It is more slender and with less inflated elytra than *obscurus*, as represented in the cabinet of Dr. LeConte; it is also decidedly smaller than that species. The specimens from Humboldt Co. are slightly smaller than those from Mendocino and differ in having slightly shorter, more convex and inflated elytra, with paler but more distinct markings, but more especially in the form of the prothorax which is decidedly more strongly inflated in the middle, and in the vestiture of the under surface of the abdomen, which in the Humboldt specimens is completely devoid of broad scales toward apex, while in the southern specimens there is a decided admixture of such scales. In antennal structure it fulfills the tabular character, and it can only be at best a local variety of *significans*.

S. brumalis n. sp.—Nearly uniform dark grayish-brown throughout, a posteriorly arcuate, very feeble, and ill-defined band crossing the elytra at the summit of the apical declivity: prothorax very slightly paler at the sides. *Head* and beak as long as the prothorax, rapidly narrowed from base to apex; alæ very slightly dilated; eyes at less than their own length from the base; surface nearly as in *significans*, the median carina being a little stronger and continuous along the apical depressed glabrous area; the latter not forming a closed angle; antennæ long, slender; scape rather strongly arcuate; funicle not incrassate, first joint one-third longer than the second, seventh very long, two-thirds longer than the sixth. *Prothorax* slightly wider than long, subcylindrical, very slightly more convex at the middle of the sides; base slightly narrower than the apex, both transversely truncate; disk rather finely, deeply, and very sparsely punctate, sparsely clothed with small semi-erect pale setæ which are much smaller and less squamiform than those of the head. *Elytra* inflated, oblong-oval, more than twice as wide as the prothorax, a little more than one-third longer than wide, rather acutely rounded behind; sides arcuate, nearly straight for a short distance in the middle; disk convex, rather flat near the suture, not perceptibly tumid near the suture behind, rather finely and deeply striate; striæ finely and not closely punctate; intervals feebly convex, each with a row of rather robust, nearly erect, pale, subsquamiform setæ. *Abdomen* more sparsely squamose toward apex, sparsely covered with rather long, recumbent whitish setæ; first suture very slightly arcuate for a very short distance in the middle; second nearly as long as the next two together. Length 5.5 mm.

California (Marin Co. 2).

In this species the claws are rather robust and but slightly

divergent, but they appear to be quite free throughout. It is easily distinguishable by its nearly uniform dark grayish color, coarse scales, and the form of the prothorax, this being slightly narrower at base than at apex.

S. arcuatus n. sp.—Rather robust, convex; scales small, rather pale, grayish-ochreous, with a narrow, dark, and even band crossing the elytra in a very feebly and posteriorly arcuate course at the summit of the declivity; other markings very indistinct and suffused, the sides of the prothorax and an imperfect, elongate oval ring at the base of each elytron paler; abdomen very sparsely squamose toward apex, sparsely. setose. *Head* and beak as long as the prothorax; the former short and broad; beak gradually narrowed to apex, slightly longer than the head; alæ not at all dilated; front with an elongate puncture between the eyes; beak broadly elevated along the middle third, the elevation broadly concave, more deeply so and finely carinate between the scrobes, glabrous near the apex and with a small declivous impressed triangular area at tip; scrobes very short, broad, deep, and cavernous, moderately convergent, vanishing at much more than their own length from the eyes; antennæ long and rather slender; scape very long, slender, strongly arcuate; funicle scarcely as long as the scape, first joint but slightly longer than the second, the latter as long as the third and fourth together; outer joints slightly more robust; club scarcely more than one-fourth as long as the scape. *Prothorax* subcylindrical, slightly wider than long, broadly and feebly constricted in the apical third; sides broadly arcuate in the middle: base transverse, very slightly wider than the apex: the latter broadly and extremely feebly sinuate in the middle; disk finely, very sparsely and unevenly punctate, with small, sparse, arcuate subrecumbent setæ. *Elytra* inflated, convex, rather acute at apex; sides arcuate; disk one-third longer than wide, slightly more than twice as wide as the prothorax, slightly tumid along the suture posteriorly, finely striate; striæ finely and distantly punctate; intervals broadly and feebly convex, each with a single and occasionally unevenly double line of small, slender, arcuate, subrecumbent piceous setæ. *Legs* rather long, densely scabrous; femora rather strongly clavate. Length 6.5 mm.

California (Mendocino Co. 1).

In this species the claws are rather robust, somewhat feebly divergent, although very distinctly separated throughout their length.

S. angustulus n. sp.—Form very slightly robust, rather depressed above; scales dark reddish-brown, two or three very small spots near the base of each elytron and a posteriorly arcuate band near the apical declivity which is slightly broken to the rear at the suture, blackish; sides and narrow median line of the prothorax just visibly

paler; abdomen sparsely squamose toward base, not at all so near the apex, somewhat sparsely clothed with rather long, erect, very fine setæ. *Head* and beak short and robust; the latter not as long as the head, distinctly wider than long, very feebly dilated at apex; front with an elongate canalicular puncture between the eyes; scrobes deep, rather large, oval, strongly convergent, approaching the eyes within their own length, inner margins slightly elevated and carinate; intermediate surface feebly concave, very obsoletely carinate, glabrous; apex with usual angulate area; antennæ rather long; scape feebly arcuate, much shorter than the funicle; first joint of the latter one-third longer than the second, the latter much shorter than the third and fourth combined. *Prothorax* cylindrical, one-third wider than long, scarcely perceptibly constricted near the apex; sides distincly arcuate in the middle; base and apex transversely truncate, equal; disk rather finely and sparsely punctate and with rather fine, long, semi-erect setæ. *Elytra* oblong, subelongate, nearly one-half longer than wide, slightly more than twice as wide as the prothorax; sides parallel and very feebly arcuate in the middle; disk feebly convex in the middle, subacutely rounded behind, scarcely perceptibly tumid on the suture behind, finely striate; striæ finely and remotely punctate; intervals nearly flat, with single and double rows of rather long, fine, nearly erect setæ which are more than usually approximate, pale and dark intermingled. *Legs* moderate, sparsely setose; femora paler and densely squamose near the apex, devoid of scales toward base; tibiæ densely squamose except near the tip which is free from scales. Length 4.7 mm.

California (Napa Co. 1).

The transverse impression at the base of the beak is rather stronger than usual and the claws are distinctly free throughout their length, although not widely divergent. The prothorax is more strongly transverse and the setæ covering the integuments are distinctly longer, finer, denser, and more erect than in the species previously described.

S. setosus n. sp.—Form rather robust, convex; scales pale grayish-white, with a suffused, outwardly oblique line, externally near the base of each elytron and a transverse, strongly and posteriorly angulate, suffused band near the apex, darker brown; sides and narrow median line of prothorax of the same color as the elytra and paler than the remainder of the disk; abdomen very sparsely squamose and with fine elongate setæ. *Head* and beak moderately robust, as long as the prothorax; the latter slightly longer than the head and fully as long as wide; sides parallel; front with a short canalicular puncture; transverse impression very strong; beak broadly and strongly elevated along the middle, the elevated area feebly carinate along the middle and also the lateral edges over the scrobes; apex with very feebly defined angulate

declivous area which is glabrous and scarcely impressed; scrobes rather large, distant, nearly parallel, vanishing at slightly less than their own length from the eyes; antennæ rather robust; scape nearly straight, scarcely attaining the prothorax, about as long as the funicle; first joint of the latter nearly as long as the next two together, seventh distinctly longer than the sixth. *Prothorax* slightly wider than long; sides broadly and distinctly arcuate nearly throughout the length, convergent and nearly straight near the apex; base transverse, slightly wider than the apex; the latter broadly, feebly, and subangularly emarginate, and fringed with very fine scales; disk convex, rather finely and densely, but somewhat unevenly punctate, finely setose. *Elytra* oval, inflated, convex, more than twice as wide as the prothorax, widely and gradually inflexed beneath, one-third longer than wide, rather broadly and evenly rounded behind from above; sides feebly arcuate; disk not tumid on the suture; the latter obliterated by the squamose vestiture, finely striate; striæ finely and distantly punctate; intervals feebly convex, with very uneven rows of fine whitish erect setæ which are rather dense and very distinct. *Abdomen* narrow and rather strongly acuminate. Length 6.0 mm.

California (Napa Co. 2; Marin Co. 2).

The scales are small and distinctly less dense than in the other species here described. This species is, moreover, aberrant in its short antennal scape, more distant and parallel scrobes, more oval prothorax, its almost perfectly oval elytra which are more broadly inflexed, and in its narrow abdomen. The pattern of elytral ornamentation is also different, the posterior transverse band not being broadly and posteriorly arcuate, but strongly angulate. In all essential points of generic structure it, however, appears to find a very fitting place in the present genus, the two additional terminal spurs of the posterior tibiæ being distinct. The claws are not strongly divergent, but free as in the other species. The scutellum is minute and triangular, but distinctly visible between the bases of the elytra.

STENOPTOCHUS n. gen. (Otiorhynchini).

This genus may be characterized in few words as follows:—

Claws connate at base. First ventral suture straight; second segment shorter than the third and fourth together. Articular surfaces of the posterior tibiæ glabrous. Beak longer than the head, feebly dilated at apex; scrobes superior, deep, short, vanishing at slightly more than their own length from the eyes, very feebly convergent. Antennæ

moderate; scape very feebly arcuate, not attaining the anterior margin of the prothorax, setose and sparsely scaly; funicle seven-jointed, distinctly longer than the scape, setose, first joint as long as the next two together; club elongate-oval, finely pubescent, scarcely one-half as long as the scape. Tibiæ distinctly mucronate throughout.

The first ventral segment is practically straight, but upon very close observation is seen to be very broadly and excessively feebly arcuate in the middle two-thirds, and exceedingly feebly and anteriorly oblique at the sides. The genus should properly be considered a connecting link between Paraptochus Seidl. and Thricolepis Horn, from both of which it is certainly distinct, according to the present mode of estimating generic differences in the group Periteli.

S. inconstans n. sp.—Moderately robust, convex, very densely clothed with rather small, minutely and densely striate scales, which are slightly wider than long; scales sparser on the legs and body beneath, entirely replaced by fine hairs towards the apex of the abdomen; general color above white, with a large, oval, darker discal area on the elytra, which is limited behind by a transverse, very irregular, angular band of white, margined anteriorly with castaneous; bases of the fourth and sixth intervals, and an elongated spot on the sixth interval, confluent behind with the white sides, also white; broad median area of the pronotum dark-brown, the stripe being slightly dilated behind and slightly paler along the median line. *Head* feebly convex, with a fine, short median stria between the eyes; the latter rather convex, at more than their own length from the prothorax; beak separated from the head by a transverse, feebly arcuate impression, longer than wide, flattened, apex glabrous and with a small, triangular, impressed area in the middle of the apical margin. *Prothorax* one-third wider than long, subcylindrical, very slightly narrower toward apex; sides broadly subangulate; base truncate; apex very broadly, feebly arcuate; disk finely, rather unevenly and not densely punctate, each puncture bearing a short, erect, squamiform seta. *Elytra* oval, in the middle twice as wide as the prothorax, one-half longer than wide; apex perpendicular, acutely rounded; disk convex, finely, deeply striate; striæ finely, not closely punctate; intervals feebly convex; suture fine, distinct. *Legs* moderately robust. Metasternal episterna narrow, distinct. Length 3.5–5.0 mm.

California (Los Angeles Co. 3).

The typical representative is the darkest in color, and the other two are so pale that the dark areas spoken of in the description can scarcely be discerned. Each elytral interval bears a single

row of long erect scales which take the color of the surface vestiture.

In the general character of elytral ornamentation, this species bears a great resemblance to *Peritelinus variegatus*, but the beak and abdomen are quite different.

ORTHOPTOCHUS n. gen. (Otiorhynchini).

Beak scarcely as long as the head, slightly narrowed toward apex; eyes large, slightly longitudinally oval, slightly convex; interocular surface nearly flat, with a short median canaliculation; beak transversely and feebly impressed at base, the channel being posteriorly arcuate, finely carinate in the middle anteriorly; scrobes superior, slightly convergent, rather distant, deep anteriorly, gradually becoming obsolete near the eyes; antennæ rather slender; scape long, very slender, feebly arcuate, extending distinctly beyond the anterior margin of the prothorax, sparsely setose, not at all scaly, fully as long as the funicle; the latter slender, first joint scarcely more robust, nearly as long as the second and third together, second distinctly shorter than the third and fourth combined, three to seven shorter, equal, longer than wide, not increasing in thickness, all coarsely setose; club elongate-oval, pointed, finely pubescent, as long as the three preceding joints together. Elytra inflated. First abdominal suture straight; second segment fully as long as the next two together. Legs moderate; tibiæ feebly dilated internally at apex, very minutely mucronate; cotyloid surfaces of the posterior glabrous. Claws connate at base. Metasternal episterna extremely narrow; suture nearly obsolete.

This genus belongs near Paraptochus, if we regard the shape of the first ventral suture as of primary importance; it differs from Peritelopsis in its straight sutures, also in being squamose, with larger erect scales intermingled.

O. squamiger n. sp.—Oval, moderately robust, convex, extremely densely covered with moderate, generally slightly transverse scales of a nearly uniform, very dark reddish-brown or castaneous color, much sparser on the abdomen, and absent toward the apex of the latter; abdomen clothed rather densely with long, robust, subrecumbent hairs. *Head* and beak conical, the sides convergent from base to apex; front densely squamose, and with a few large erect scales between the eyes; apex glabrous, and with but slight trace of a defined angular impression, feebly rugulose. *Prothorax* slightly shorter than the head and beak, two-fifths wider than long, subcylindrical, very feebly narrowed toward apex; sides broadly arcuate or subangulate; base transverse; apex broadly, very feebly arcuate; disk convex, covered with a dense uniform mass of scales, with a few short, robust and erect, not percep-

tibly punctate. *Elytra* inflated, convex, twice as wide as the prothorax, one-third longer than wide; sides arcuate; together rather pointed behind, very finely, feebly striate, not visibly punctate; intervals nearly flat, each with a single row of very widely spaced, short, robust, erect scales. Length 3.7 mm.

California (exact locality not known).

I have before me but a single specimen of this small species, the characters of which appear to necessitate the creation of a new genus.

PERITELODES n. gen. (Otiorhynchini).

Beak very short, scarcely as long as the head; sides parallel, slightly dilated at apex; scrobes narrow, deep, very widely separated, very feebly convergent, not attaining the eyes; the latter rather large, widely distant, feebly convex, at their own length from the prothorax; front flat, separated from the beak by a transversely sinuate, very feeble impression; antennæ moderate; scape densely squamose, setose, rather robust, strongly arcuate, not quite attaining the prothorax, and distinctly shorter than the funicle; the latter slender, nearly equal in thickness throughout, setose, sparsely squamulose toward base, basal joint nearly as long as the next two together, second nearly as long as the third and fourth combined, outer four joints much longer than wide, equal in length; club elongate-oval, finely pubescent. Prothorax cylindrical. Elytra strongly inflated. First abdominal suture very feebly arcuate in the middle; second segment as long as the next two together. Legs robust; posterior tibiæ with two fixed approximate terminal spurs which are truncate at apex; cotyloid surface glabrous. Claws strongly connate at base.

This genus differs from Peritelinus, to which it is otherwise very closely related, in having two fixed terminal spurs to the posterior tibiæ; the first ventral suture is much more feebly and less broadly arcuate in the middle, and the second segment slightly shorter than in that genus.

P. obtectus n. sp.—Rather robust, convex, densely clothed with dark-brown scales which are whiter on the flanks and along the median line of the prothorax, and with a few white scales irregularly scattered over the elytra; scales rather convex, wider than long, oval, finely and rather distinctly strigate; abdomen more sparsely squamose, scarcely more sparsely so toward apex, and with rather robust white setæ, scales white. *Head* and beak distinctly longer than the prothorax; the latter scarcely as long as the head and slightly wider than long, having at apex a short, broadly angular impressed glabrous area, bounded posteriorly by a raised carina, and having its apex broadly, angularly emargi-

nate; surface densely squamose, and with a few very robust erect scales near the eyes. *Prothorax* nearly one-half wider than long, feebly and broadly constricted in the apical third, cylindrical; base and apex equal, truncate; sides feebly arcuate in the middle; disk very finely and sparsely punctate, having a few erect scales, especially along the apex. *Elytra* strongly inflated, more than twice as wide as the prothorax, one-third longer than wide, rather acuminate at apex; sides arcuate; disk convex, finely striate; striæ feebly impressed, very finely, obsoletely, and distantly punctate; intervals feebly convex, each with a very widely spaced row of robust, erect, piceous scales. *Legs* robust, densely squamose, sparsely setose. Metasternal episternum rather wide; suture only distinct anteriorly. Length 5.4 mm.

California (Monterey Co. 1).

The type specimen, which was taken near the town of Monterey, is covered in great part with a scabrous coating, which appears to have been caused by a viscous exudation. The species differs greatly in habitus and ornamentation from *Peritelinus variegatus*, having much more globose and inflated elytra.

PERITELINUS n. gen. (Otiorhynchini).

P. variegatus n. sp.—Somewhat robust, convex, densely clothed with scales which are rather small, round, and excessively minutely and densely striate; general color above dark reddish-brown, beneath whitish, broad median area of pronotum brown, very distinctly limited at the sides; elytra at the sides beneath whitish, the white area crossing the elytra near the apex in a very irregular angular band, edged anteriorly with blackish, the fourth and sixth intervals, near the base, and a spot on the sixth interval, near the middle, also white. *Head* broad; beak much narrower than the head, and about equal in length, wider than long, dilated at the apex, separated by a transverse impression, a triangular impressed area at tip glabrous; eyes rounded, rather large, feebly convex, at nearly their own length from the base; surface densely squamose, and with sparse, erect, squamiform hairs; antennæ moderate; scape slightly arcuate, just attaining the anterior margin of the prothorax, densely scaly, and with short, erect, robust setæ; funicle with the first joint as long as the next two together, setose and sparsely scaly; scrobes short, deep, superior, not attaining the eyes, very feebly convergent. *Prothorax* cylindrical, one-half wider than long; sides broadly arcuate; base and apex equal, transversely truncate; disk slightly shorter than the head and rostrum, rather finely, densely, and deeply punctate, each puncture bearing a short, robust, erect fuscous seta. *Elytra* inflated, two-fifths longer than wide, in the middle slightly more than twice as wide as the prothorax, perpendicular behind; apex not inflexed, rather acutely angulate; disk

convex, finely striate; striæ finely, deeply, and not closely punctate; intervals feebly convex, each with a single, or occasionally partly double, line of short, erect, squamiform setæ, generally piceous, but sometimes white, in the transverse white band; suture fine, but distinct. *Abdomen* more sparsely squamose, and with short, robust, white setæ; second segment slightly longer than the next two together; first suture abruptly, broadly, and distinctly arcuate in the middle half. Length 4.0 mm.

California (Lake Tahoe, 1).

This species is placed in the new genus Peritelinus, but might with almost equal propriety be assigned to Peritelopsis; in fact it is possible to erect a separate genus for almost every species of the group Periteli known to our fauna, as in many parts of the Cerambycide series. It differs from Thricolepis in its shorter dilated beak, and less strongly arcuate first ventral suture, and from Peritelopsis in its longer second ventral segment and the scrobes very feebly convergent and not attaining the eyes. The claws are connate at base, the cotyloid surfaces of the posterior tibiæ glabrous, and the metasternal episterna very narrow and linear.

GEODERCES Horn.

A small species before me appears to fulfill most of the conditions mentioned by Dr. Horn in his diagnosis of the above genus, but has the antennal scrobes slightly more open when viewed vertically than when seen laterally, and the beak is scarcely perceptibly impressed at base. The anterior tibiæ have some robust internal spines, but are not denticulate. The articular surfaces of the posterior tibiæ are glabrous, the first ventral suture broadly and excessively feebly arcuate, the second segment as long as the next two together, and the claws connate at base.

G. puncticollis n. sp.—Rather robust, convex; scales very small, rounded, very dense, generally very dark rufo-castaneous; elytra very feebly and finely mottled with paler scales which are unevenly distributed; scales sparser and intermixed with fine hairs on the abdomen. *Head* short; eyes rather small, slightly convex, scarcely distant their own length from the prothorax; beak scarcely longer than and nearly as wide as the head, wider than long; sides parallel, surface broadly, feebly impressed, finely carinate in the middle, with a triangular impressed glabrous area at apex; scrobes parallel, deep, cavernous, slightly more open from above, nearly attaining the eyes; antennæ rather slender; scape extending distinctly beyond the anterior margin

of the prothorax, very feebly arcuate, subequal in length to the funicle, rather densely squamose, setose; funicle setose, slender, first two joints longer, first distinctly more robust and slightly longer than the second; club elongate-oval, two-fifths as long as the scape. *Prothorax* as long as the head and beak, two-fifths wider than long, distinctly narrowed toward apex and inflated behind the middle; sides rather strongly arcuate behind, convergent and feebly sinuate toward apex; base and apex broadly and very feebly arcuate; disk convex, coarsely, deeply, and sparsely punctate, with coarse erect setæ, and a fine short glabrous carina in the middle. Scutellum minute, not distinct. *Elytra* at base broadly sinuate, to fit the arcuate margin of the pronotum, oblong-oval, broadly rounded behind, not twice as long as wide, nearly twice as wide as the prothorax, feebly convex above, strongly so at the sides, finely and feebly striate; striæ very finely and not closely punctate; intervals flat, sparsely covered with fine erect piceous setæ, which are not arranged in rows, but scattered uniformly over the surface. *Legs* short and robust: tibiæ mucronate. Length 4.2 mm.

California (Monterey Co. 1).

The vittæ of pale scales at the sides of the prothorax are very obscure and only visible near the base, where they confront a very small humeral pale spot. This species is decidedly smaller than *incomptus* Horn.

GEODERCODES n. gen. (Otiorhynchini).

Beak slightly longer than the head, slightly narrowed toward tip, not transversely impressed at base; scrobes lateral, slightly descending posteriorly, attaining the eyes which are surrounded above and beneath by a fine impressed channel. Antennæ moderate; scape fully attaining the prothrorax, distinctly arcuate, equal in length to the funicle, squamose and setose; funicle slender, first joint more robust, nearly as long as the next two together; second slender, as long as the third and fourth combined; seventh slightly longer and wider than the sixth, all coarsely, sparsely setose, not at all squamose; club rather small, very densely and finely pubescent, oval, pointed. Elytra widely embracing the sides of the body. Metasternal episterna very narrow, linear, distinct. Abdomen with the first suture broadly, feebly, but distinctly arcuate; second segment slightly longer than the third and fourth together: the latter very short, equal and with the sutures very deeply impressed. Legs rather short and robust; cotyloid surface of posterior tibiæ glabrous; tibiæ finely mucronate, the anterior not denticulate, but having two or three inclined spines along the inner edge toward apex. Claws connate at base.

As can be readily seen from the above diagnosis, this genus differs from Geoderces in its longer second segment of the abdo-

men, in the extent of the antennal scrobes, and in the impressed groove surrounding the eye above and beneath, this appearance being caused by the partial envelopment of the latter by the scrobes.

G. latipennis n. sp.—Form oblong, convex, densely clothed with small, rounded, rather coarsely striate scales which are brownish, ferruginous, and blackish, indiscriminately mingled on the prothorax, and more coarsely and very irregularly mottled on the elytra; abdomen densely squamose toward base, very sparsely so toward apex, and with very sparse, coarse, short, erect setæ. *Head* and beak conical with the sides continuous and distinctly convergent from base to apex; eyes widely distant, rounded, rather small and convex, the surface of the head somewhat elevated above them and slightly prominent above their upper edge; front with a short, impressed, median and longitudinal groove between the eyes, which becomes a fine carina toward apex the latter with a very small, triangular, impressed, glabrous area which is broadly emarginate at apex; antennæ affixed slightly beyond the middle, the scrobes extending nearly to the apex. *Prothorax* one-third wider than long, convex, feebly but distinctly constricted near the apex and inflated behind the middle; sides strongly arcuate behind; base truncate, distinctly wider than the apex; the latter broadly and distinctly arcuate; disk finely, not densely, and very indistinctly punctate, with very short, erect, sparse setæ. Scutellum not distinct. *Elytra* oblong, slightly longer than wide, more feebly convex above; sides parallel, nearly straight, very broadly rounded behind; base broadly emarginate opposite the prothorax; disk twice as wide as the pronotum, very finely and obsoletely striate; the striæ not perceptibly impressed, and very finely, feebly, and not closely punctate; intervals flat, each with a single widely spaced, and somewhat uneven row of elongate, erect, squamiform hairs; each elytron is distinctly tumid or umbonate near the apex externally. *Legs* sparsely squamose and setose. Length 3.0-3.5 mm.

California (Monterey Co. 3).

Found in limited numbers near the town of Monterey under the fallen leaves of the Monterey pine.

ARAGNOMUS Horn.

A. hispidulus n. sp.—Rather robust, very densely clothed with rounded, pale-brown scales, which are coarsely striate, slightly paler along the median line of the prothorax, unevenly clouded with paler on the elytra, where there is a posterior faint angulate band of darker tint; scales slightly smaller and sparser on the abdomen, where they are mingled with erect hairs, rather densely so toward apex; legs with

scales and erect squamiform hairs. *Head* rather depressed, but slightly wider than the beak; the latter very slightly longer than wide, distinctly dilated at tip, arcuately and transversely impressed at base; surface broadly impressed; upper margins of antennal scrobes rather elevated; apex with a triangular denuded area which is limited by an angulate ridge, the angle continued posteriorly for a very short distance by a distinct carina; surface with sparsely placed erect scales, denser over the eyes; the latter rather large, feebly convex; antennæ rather long; scape arcuate, extending distinctly beyond the anterior margin of the prothorax, squamose, and with erect robust hairs; funicle coarsely setose, one-third longer, slender, first joint nearly one-half longer than the second; club elongate-oval, finely pubescent. *Prothorax* one-half wider than long; sides parallel, broadly arcuate; base and apex transversely truncate; disk scarcely as long as the head and beak together, cylindrically convex, rather finely and not densely punctate, each puncture bearing a long erect pale scale. *Elytra* inflated, declivous at apex; the latter slightly inflexed and acutely angulate; disk convex, one-third longer than wide, in the middle twice as wide as the prothorax, connate, suture entirely invisible and covered by the vestiture, finely striate; striæ rather deeply impressed, finely and not closely punctate; intervals feebly convex, each with a single or partially double row of long, erect, distant scales, which are cinereous and brown intermixed. *Legs* rather short and robust. *Abdomen* with the first suture broadly, feebly arcuate; second segment equal in length to the next two together. Length 5.5 mm.

California (Los Angeles 1).

The antennal scrobes are lateral, deep, nearly straight, and directed upon the eyes which they do not attain. It is the largest species of the genus.

THINOXENUS Horn.

T. nevadensis n. sp.—Form oblong-elongate, convex, clothed very densely with small rounded scales, dark brown, feebly and unevenly mottled paler and darker; abdomen covered throughout with a dense crust of similar scales, with intermixed elongate squamiform hairs. *Head* and beak conical, flattened; occiput convex; beak with a short median stria in the basal half, and a small triangular impressed glabrous area at apex, the sides of which are in the form of acute ridges; surface densely covered with scales, with short erect scales intermingled; eyes very distant, on the sides, rounded, rather small, moderately convex; scrobes widely distant, more open laterally, narrow and deep near the apex, broad and evanescent well before the eyes, the alæ very wide but not dilated; antennæ inserted nearly at the apices of the scrobes; scape densely scaly, feebly arcuate and extremely feebly contorted, attaining the prothorax; first joint of funicle one-half longer than the

second. *Prothorax* one-half wider than long, but slightly wider than the head, slightly shorter than the head and beak, cylindrical; base and apex equal, truncate; sides broadly and rather strongly arcuate; disk finely, feebly, and not densely punctate, the punctures entirely concealed by a dense mass of scales, with small, short, erect scales intermingled. *Elytra* broadly emarginate at base, oblong, one-half longer than wide; sides nearly straight and parallel, broadly rounded behind, three-fourths wider than and nearly three times as long as the prothorax, finely, feebly striate; striæ coarsely and rather distantly punctate, the punctures and suture almost completely concealed by the surface vestiture; intervals nearly flat, each with an unevenly double row of small erect brown scales. First ventral suture broadly and rather strongly arcuate; second segment as long as the next two together; third and fourth subequal; fifth semicircularly rounded behind. *Legs* densely squamose, and with short semi-erect scales. Metasternal episternum narrow; suture very deep anteriorly, becoming almost obsolete posteriorly. Length 4.4 mm.

Nevada (Washoe Co. 1).

The groove surrounding the eye is narrow and not very deep; it is obsolete behind the eye. This species differs from *squalens* Horn in its more oblong form, more transverse prothorax, and more robust or squamose and paler setæ.

A considerable number of new genera of Periteli having been defined, it may, perhaps, be well to more fully explain their position with regard to those already described; the following table is therefore appended, this being an enlargement of the one given by Dr. Horn (Proc. Am. Phil. Soc., XV., p. 65):—

First abdominal suture straight or extremely nearly so.
  Scrobes lateral.. ....**Paraptochus**
  Scrobes superior.
    Antennal scape not attaining the prothorax; eyes small; second ventral segment shorter than the two following together, **Stenoptochus**
    Antennal scape long and slender, passing distinctly beyond the anterior margin of the prothorax; eyes large; second segment as long as the two following together.............**Orthoptochus**
First abdominal suture arcuate.
  Cotyloid surface of the hind tibiæ glabrous; eyes with or without orbital groove.
    Integuments sparsely pubescent.......................... ....**Mylacus**
    Integuments squamose.
      Scrobes superior and convergent above.
        Beak narrowed to tip.

Beak longer than the head; scrobes very short, terminal, **Thricolepis**

Beak shorter than the head; scrobes attaining the eyes, **Peritelopsis**

Beak dilated at apex, short; scrobes very feebly convergent, short, not attaining the eyes; second ventral segment as long as the third and fourth.

Posterior tibiæ with two short fixed spurs. ...**Peritelodes**

Posterior tibiæ without fixed spurs........ ...**Peritelinus**

Scrobes more lateral, not convergent above.

Scape about as long as the funicle.

Scrobes not attaining the eyes.................**Geoderces**

Scrobes attaining and partially enveloping the eyes, **Geodercodes**

Scape much shorter than the funicle... ....**Aragnomus**

Cotyloid surface of the hind tibiæ squamose.

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NOTE.—In the species *puncticollis*, which I have assigned to Geoderces, the scrobes are slightly more open when viewed from above, and as this is a much smaller species than those forming the types of the genus, it may possibly necessitate the creation of a subgenus.

PANORMUS n. gen. (Otiorhynchini).

Body oval; elytra inflated; similar in form to Trigonoscuta. Head hemispherical; beak much narrower and longer than the head; sides parallel: alæ slightly dilated; surface not broadly impressed at base, but having a fine arcuate groove between the anterior extremities of the eyes, finely grooved along the middle, the groove crossing the transverse basal channel and extending slightly onto the front. Eyes oval, distant from the prothorax, rather small, coarsely granulated and prominent. Scrobes lateral, rather narrow, deep anteriorly, gradually evanescent, feebly arcuate, directed upon and nearly attaining the eyes. Antennæ subapical, shining, setose; scape slender, very gradually and feebly clavate toward apex, fully as long as the funicle, extending beyond the eye, but not attaining the prothorax; funicle seven-jointed, basal joint nearly as long as the next two together, second longer than the third, outer joints moniliform and short, seventh wider, transversely oval; club rather short and robust, ovoidal, pointed. Prothorax without trace of ocular lobes or fimbriæ, broadly inflated. Scutellum minute, indistinct. Elytra inflated, very feebly inflexed at the sides. Abdomen flat; first suture arcuate in the middle; second segment as long as the next two combined. Legs moderate; femora robust; tibiæ and tarsi slender; anterior tibiæ straight, slightly produced outward and dilated at apex, not denticulate within; posterior tibiæ with outer edge at apex broadly double; inner face or cotyloid surface slightly oblique, plane, with a few scattered scales; inner terminal spur rather large and

distinct. Posterior coxæ small, at the sides of the body and very remote. Tarsi densely pubescent beneath, with the basal joint elongate; third strongly dilated, deeply bilobed; fourth long, slender; claws moderate, free. Metasternal side-pieces narrow but distinct, the suture much deeper behind.

The mentum is loosely articulated with a narrow and rather prominent basal support or peduncle; it is rather small, nearly flat, slightly wider than long, narrowed from apex to base, the posterior portion parabolic, the apex broadly angulate, the angle slightly thickened and tumid in the middle; at the sides the maxillæ are partially exposed, much more widely so toward base. The genal emarginations are small, but rather deep; the mandibular scar rather large and prominent, rounded.

The antennal grooves have a certain tendency to descend as they approach the eyes, but this is very slight, and, as the general appearance is decidedly that prevailing in the Otiorhynchini, I have there assigned it a place among the Trachyphlœi, although it is one of those forms the position of which must, under the present system of classification, be more or less doubtful. It appears to possess considerable affinity with Agasphærops Horn of the Brachyderini, another genus of doubtful position, but differs in the size of the mentum and in antennal structure.

The single species is rather densely covered throughout with somewhat long erect cinereous setæ, these not being regularly arranged on the elytra, and the general sculpture is very similar to that prevailing in Amnesia.

P. setosus n. sp.—Oval, convex, black; legs and antennæ fuscous; entire body covered with a thin indument, composed of small, closely adherent scales which do not overlap, with some pale scattered scales at the sides of the prothorax and elytra. *Occiput* convex; front flat; beak flat, apex truncate, not distinctly angularly impressed; entire surface finely granulose. the granules well separated, and each formed by a thickened scale. *Prothorax* broadly convex, nearly one-half wider than long, widest in the middle; sides strongly arcuate, broadly rounded anteriorly, feebly convergent, and nearly straight toward base; the latter broadly arcuate, fitting against a corresponding emargination in the base of the elytra; apex broadly emarginate, about two-thirds as wide as the base; disk coarsely, densely, and strongly granulose, each granule punctured and bearing a long erect seta. *Elytra* oval, convex, widest at anterior third; apex strongly declivous and slightly inflexed, four-fifths wider than the prothorax, one-third longer than wide, rather

strongly rounded behind from above; humeri obsolete, broadly rounded; disk rather smooth, shining; striæ not impressed, composed of moderate rounded, deeply impressed punctures which are separated by from two to three times their own widths; tenth series very close to the ninth at anterior third. *Abdomen* and legs more sparsely clothed with long erect hairs. Length 5.3 mm.

California (Monterey Co. 1). Mr. W. G. W. Harford.

The type specimen has the basal segments of the abdomen broadly and strongly impressed in the middle.

ELISSA n. gen. (Tanymecini).

Form subcylindrical. Entire body covered with a thin, scabrous waterproof crust, the squamose nature of which can only be detected on the elytra and under surface. Head very wide; beak but slightly longer than the head, much wider than long, narrowed toward apex; the latter truncate and broadly trisinuate; surface nearly flat; alæ very feeble; scrobes small, lateral, beginning at the apex, where they are narrow and deep, passing rapidly and arcuately downward in front of and at a distance from the eyes, becoming broader and more shallow. Antennæ slender, sparsely setose, subapical; scape slender, abruptly clavate, extending slightly upon the eye, as long as the funicle; the latter slender, basal joint slightly clavate, longer than the second, the latter longer than the third, outer joints but slightly enlarged; club slender, elongate-oval, pointed. Mandibular scar feeble, narrow, transverse. Mentum very large, completely filling the gular cavity, flat, transverse, widest at apex, margin broadly arcuate. Eyes small, rounded, coarsely granulated, free, prominent. Prothorax without ocular lobes, but having a short fringe of long stiff setæ. Elytra not distinctly striate. Scutellum very minute, triangular. Abdomen nearly flat; second segment fully as long as the third and fourth combined, separated from the first by a broadly arcuate suture. Legs rather slender; cotyloid surfaces of the posterior tibiæ terminal, not cavernous; tarsi rather slender: basal joint much longer than wide; third very slightly wider than the second, bilobed; fourth as long as the two preceding combined; claws slender, moderate in length, free. Posterior coxæ small, at the sides of the body, very widely separated.

The mesosternal episternum is separated completely from the elytra by the epimeron, and the metasternal episternum is extremely narrow and linear, the suture very feeble. The genæ are rather deeply emarginate, and the anterior coxæ contiguous.

The species, which are subaquatic, may be separated as follows:—

Prothorax obtrapezoidal, wider at apex than at base, not perceptibly constricted at apex..................... .... **laticeps**
Prothorax widest just before the middle, strongly constricted just behind the apical margin........................ ... ...**constricta**

E. laticeps n. sp.—Form rather elongate, convex, covered with a whitish or ferruginous-white waterproof indument. *Head* and beak about as long as wide; surface finely rugulose, with a few widely scattered, minute, erect squamiform setæ, especially near the apex; front feebly convex, not at all impressed at the base of the beak; the latter very short, broad, rapidly narrowed toward apex; surface nearly flat, with an elongate median puncture; antennæ shining, rufous, slender, sparsely setose, unevenly and partially covered, except the club, with a white scaly indument; outer joints of funicle longer than wide. *Prothorax* widest at apex, where it is scarcely as wide as the head across eyes, gradually narrowed toward base; sides very feebly arcuate; base and apex truncate; disk one-third wider than long, rather coarsely but not deeply rugulose, with a few widely scattered, minute, erect scales. *Elytra* elongate-oval; sides nearly straight and parallel, very declivous behind, but not quite perpendicular, together acute at apex; humeri broadly rounded; base transversely truncate; disk convex, one-half wider than the prothorax, nearly one-half longer than wide, not striate, shining, and very minutely and feebly rugulose beneath the crust, and having widely distant rows of very minute, shallow, widely distant punctures, and a few small erect scales, especially toward tip, and on the humeri. *Legs* and abdomen with minute, sparse, setiform scales. Length 3.8–4.7 mm.

Texas (El Paso).

This species was taken in abundance by Mr. G. W. Dunn in the locality indicated. The specimens exhibit but slight variation.

E. constricta n. sp.—Form rather elongate, densely covered with a whitish waterproof indument. *Head* and beak much longer than wide; surface finely, densely, and feebly ruguloso-punctate, with very minute erect setæ; front convex, especially near the base of the beak, the convexity extending onto the latter, which is slightly narrower than the head, as long as wide and very feebly narrowed toward apex; alæ very small, feebly dilated; apex truncate, broadly, feebly trisinuate; surface broadly, triangularly impressed at tip; antennæ well developed; scrobes nearly as in *laticeps;* scape slender, clavate, extending to the posterior margin of the eye; funicle equal in length to the scape, outer joints not appreciably enlarged, first nearly twice as long as and more robust than the second, joints two to six decreasing uniformly and very gradually in length, seventh scarcely as wide as long; club ovoidal, pointed, as long as the first and second joints of the funicle combined.

Prothorax widest just before the middle; sides strongly rounded, thence convergent and nearly straight to the base, strongly constricted near the apex; base and apex transversely truncate, nearly equal, the former sinuate in the middle; disk before the middle distinctly wider than the head, slightly wider than long, narrowly and feebly grooved along the middle from near the apex to the base; surface convex, finely, feebly, and densely ruguloso-punctate, with a few fine, elongate, squamiform hairs along the basal margin and on the sides anteriorly. *Elytra* elongate-oval, one-half longer than wide, nearly twice as wide as the prothorax; humeri broadly rounded; sides very feebly arcuate; base truncate; disk convex, very broadly, feebly, and indefinitely striate, having ill-defined rows of very sparsely scattered, excessively minute and scarcely discernible setæ. *Legs* and under surface with very minute, erect, white setæ. Legs and antennæ rufous, body black. Length 4.0 mm.

Arizona (Yuma). Mr. G. W. Dunn.

Found in very limited numbers. The apical margin of the prothorax behind the eyes has a few long erect vibrissæ, and, in addition, a dense row of broad scales which overlap. The sides of the head are slightly tuberculate above the eyes. The fourth tarsal joint is relatively longer, and the third more widely dilated than in *laticeps*.

PSEUDELISSA n. gen. (Tanymecini).

Beak short, very slightly narrowed toward tip; scrobes lateral, rather long, strongly angulate at anterior third, beginning at the apex, narrow and deep throughout, apical portion parallel, then descending obliquely and terminating just below the anterior limits of the eyes. Antennæ moderate, subapical; scape slender, feebly clavate, extending nearly to the middle of the eye, but slightly shorter than the funicle; basal joint of the latter slightly more robust, as long as the next two together, second as long as the third and fourth combined, joints three to seven subequal, the latter slightly wider than long; club elongate, ovoidal, pointed, finely pubescent. Eyes small, rounded, slightly prominent, nearly in contact with the prothorax. The prothorax subcylindrical, without ocular lobes and almost completely devoid of vibrissæ. Scutellum scarcely entering the elytral disk. Elytra elongate-oval; humeri rounded. Legs moderate; tarsi short, basal joints short, subequal, third scarcely perceptibly wider than the second, deeply emarginate, fourth as long as the three preceding together. Anterior coxæ contiguous; posterior small, at the sides of the body, very widely separated. First abdominal suture broadly and distinctly angulate; second segment distinctly longer than the third and fourth combined.

The genæ are narrowly and deeply emarginate, the mesosternal side-pieces completely divided, the mentum rather small, scarcely wider than long and rather deeply seated, gular opening small, and the mandibular scar strongly transverse, oval and somewhat prominent.

This genus greatly resembles Elissa in general characters, but differs in the nearly obsolete vibrissæ, and the shorter basal joint of the tarsi. The single species is probably subaquatic.

P. cinerea n. sp.—Form rather slender, convex, entirely covered with a dense crust of pale cinereous scales, slightly mottled with brown on the head and elytra, and with very feebly defined vittæ of the same tint at the sides and along the middle of the pronotum. *Head* and beak small, distinctly longer than wide; front strongly and coarsely rugulose, convex; beak feebly impressed, truncate and feebly trisinuate at apex; alæ small; antennæ fuscous. *Prothorax* widest at anterior third, where it is distinctly wider than the head and very slightly wider than long; sides broadly rounded anteriorly, feebly convergent and nearly straight thence to the base, not at all constricted near the apex; base transversely truncate, subequal to the apex; the latter very broadly arcuate; disk rather coarsely, deeply, irregularly and densely punctate. *Elytra* elongate-oval, two-thirds longer than wide, two-thirds wider than the prothorax; sides parallel and nearly straight in the middle; humeri broadly rounded, not at all prominent; disk convex, coarsely and moderately deeply striate; striæ rather closely, coarsely, and deeply punctate; intervals feebly convex, each with a row of minute erect scales. Under surface with small erect setæ, slightly denser on the tibiæ; tarsi setose beneath. Length 3.0 mm.

Texas (El Paso). Mr. G. W. Dunn.

The surface of the head and prothorax is covered rather densely with very small, erect, scale-like setæ, and the latter has, near the anterior margin and laterally, and also along the basal margin, a few widely distant erect scales, which are slender and rather long. This species is apparently much less abundant, but few specimens having been obtained.

SCYTHROPUS Sch.

The species of this genus are somewhat numerous [1] and differ considerably amongst themselves in abdominal structure, as

[1] One of the finest species of this genus, represented by a single specimen from Colorado in the cabinet of Dr. Le Conte, has yet to be described.

well as in the structure of the antennæ, tarsi, and elytra. Those before me may be easily identified as follows:—

Antennal scape long, slender, passing distinctly beyond the posterior margin of the eyes.
  Elytra tumid at the sides along the humeral interval ...... **lateralis**
  Elytra evenly convex at the sides.
    Elytral setæ fine and hair-like; pronotal scales very elongate.
      Second abdominal segment much shorter than the next two combined; anterior tibiæ evenly arcuate within ..... **californicus**
      Second abdominal segment fully as long as the next two combined; anterior tibiæ feebly emarginate within, near the apex .... **ferrugineus**
    Elytral setæ in the form of elongate scales; pronotal scales short, broadly oval .... **cinereus**
Antennal scape very short, robust, and arcuate, just passing the posterior margin of the eyes .... **crassicornis**

Lateralis is a distinctly specialized form, differing greatly from the other species in the prominently elevated humeral interval of the elytra, and its larger and less prominent eyes.

The species *californicus* Horn is quite abundant in the foot hills of the Sierras near Sacramento.

S. lateralis n. sp.—Form oblong, rather depressed, densely clothed with finely strigose scales which are twice as long as wide, and acutely pointed, scales subcupreous in color, cinereous at the sides and beneath; each of the small punctures of the elytral striæ bearing a minute robust seta, otherwise devoid of setæ, except beneath, where they are fine, rather long, and sparse on the abdomen; integuments black, legs and antennæ rufous. *Head* and beak together evenly conical, convex, densely punctate, with a small, very deep fovea in the middle of a line through the anterior margin of the eyes, which is continued anteriorly to the posterior tumid margin of the apical impression; the latter large, occupying two-fifths the entire length of the beak, inclosing a posteriorly arcuate, lunate, squamose area of scales, otherwise smooth, polished, and almost impunctate, having on each side an oblique line of three long discal setæ; scrobes apical, small, deep, irregularly punctiform, far in advance of the eyes; antennæ long and slender; scape very slender, not quite reaching the anterior margin of the prothorax; abruptly, but moderately clavate at apex; funicle slender, longer than the scape; outer joints not at all enlarged, all longer than wide; basal joint very long, slender, as long as the next two together; fifth joint shortest, sixth and seventh equal in length; club elongate, slender. *Prothorax* nearly one-half wider than long, widest distinctly before the middle; sides feebly arcuate, thence extremely feebly convergent and very feebly arcuate to the base, more rapidly convergent and distinctly sinuate to

the apex; the latter distinctly narrower than the base, broadly and very feebly sinuate in the middle; base broadly subtruncate; disk broadly, evenly, and feebly convex, finely, not deeply and very densely punctate; punctures polygonally crowded. *Elytra* oblong, four times as long and nearly twice as wide as the prothorax; sides nearly straight, parallel, very broadly and feebly sinuate behind the humeri; the latter narrowly rounded, rectangular; disk broadly, evenly convex, finely striate; striæ finely, rather closely punctate; intervals nearly flat, equal, except the humeral interval, which is distinctly elevated nearly throughout its length; the flanks beyond the elevation being nearly flat, vertical, and with paler scales. *Abdomen* broadly convex, densely squamose; first suture abruptly and rather strongly arcuate in circular segment in the middle two-fifths; second segment as long as the next two together; third longer than the fourth. *Legs* moderate; anterior and middle tibiæ strongly, roundly, and almost equally emarginate within near the apex; tarsal claws small, connate at base. Length 7.5 mm.

California (Lake Co.). Mr. L. E. Ricksecker.

The mandibular scar is rather large, terminal, circular, and very distinct, not prominent within; outer margin slightly so. The mentum is small, elongate, attenuate, flat, and more deeply seated behind, very convex and prominent anteriorly, leaving the maxillæ and palpi well exposed. The mandibular notch of the genæ is extremely broad and shallow.

This species differs from *elegans* in its more depressed form and much more transverse prothorax.

S. ferrugineus n. sp.—Form elongate; sides nearly parallel; bright rufo-ferruginous throughout, scales same, whitish beneath and on the elytral suture and toward tip in large marmorate masses, also feebly so at the sides and narrowly along the middle of the pronotum. *Head* and beak evenly conical; eyes rather large and prominent; front nearly flat; beak slightly shorter than the head, as long as wide, feebly impressed and foveate near the base, broadly and arcuately impressed at tip; antennæ long and slender; surface rather densely punctate, shining, sparsely clothed with elongate squamiform hairs of various widths. *Prothorax* nearly one-half wider than long, widest just before the middle; sides thence feebly convergent and nearly straight to the base, rather strongly and abruptly constricted at the apex; base and apex transversely truncate, the former slightly the wider; disk broadly convex, rather densely punctate; punctures oval, shallow, and variolate, separated by less than their own widths; interspaces polished; scales sparse, very slender, arranged transversely, slightly more robust along the median line and at the sides. *Elytra* elongate, widest at posterior third, declivous behind, acutely rounded at tip, width at the humeri, which are obtusely prominent and rather narrowly rounded, one-third

greater than the prothorax; disk moderately convex, even, slightly more than twice as long as wide, finely striate; striæ feebly impressed, rather finely, deeply, and closely punctate. *Abdomen* convex. *Legs* sparsely clothed with fine whitish hairs. Length 5.3 mm.

California (Marin Co. 2). Mr. G. W. Dunn.

Easily distinguished from *californicus* Horn by its much sparser vestiture, composed of scales which are much more elongate, by its longer second ventral segment, and many other characters. In *californicus* the abdomen beneath is densely clothed with scales throughout, while in *ferrugineus* these become very sparse toward apex, where they are replaced by fine sparse hairs.

S. cinereus n. sp.—Form rather elongate, convex, uniformly and sparsely covered with rather robust cinereous scales which are well separated on the head and elytra, denser on the median line of the pronotum toward base, slightly sparser toward the abdominal vertex. *Head* and beak conical; alæ almost obsolete; front rather convex; beak as long as the head, broadly impressed and with a very minute fovea near the base, broadly, feebly, arcuately impressed at apex; antennæ long and slender; basal joint of funicle nearly as long as the next two together, joints three to seven uniformly and rather rapidly decreasing in length, the latter longer than wide; eyes prominent, finely granulated. *Prothorax* widest at basal third, where the sides are rather strongly rounded, thence convergent and nearly straight toward base and apex, not perceptibly constricted near the apex; base and apex transversely truncate, the former distinctly the wider; disk convex, one-third wider than long, rather finely and densely punctate; scales slightly longer and denser at the sides and in the middle. Scutellum small. *Elytra* oblong, very slightly wider at posterior third; humeri rather prominent; narrowly rounded, one-third wider than the prothorax; disk nearly twice as long as wide, acute at tip, rather convex, very finely striate; striæ scarcely at all impressed, finely and not very closely punctate; intervals flat, each with a row of erect scales. First ventral suture abruptly emarginate in circular arc in middle two-fifths; second segment fully as long as the next two together. *Abdomen* rather strongly convex. *Legs* moderate; femora rather sparsely squamose; tibiæ more densely and finely pubescent; anterior tibiæ strongly arcuate within toward apex. Length 6.0 mm.

California (Lake Tahoe 1).

Rather more robust than either *californicus* or *ferrugineus*, from both of which it is easily distinguishable by the characters given.

S. crassicornis n. sp.—Rather slender; integuments black; tibiæ, tarsi, and antennæ dark rufous; rather densely clothed with somewhat

elongate scales which are ferruginous and white, confusedly mottled over the entire surface of the elytra, white at the sides and base of the pronotum and on the under surface. *Beak* very small, shorter and narrower than the head, rapidly attenuate; sides straight; alæ obsolete; front broadly convex, with a small fovea between the anterior portions of the eyes; the latter convex and prominent, beak broadly declivous at apex; antennæ rather short; scape very short, robust, and arcuate, much shorter than the funicle, very gradually enlarged from base to apex; first joint of the funicle rather robust, scarcely as long as the next two together, outer joints slightly enlarged and more densely setose, seventh slightly longer than wide. *Prothorax* very short, nearly two-thirds wider than long, widest in the middle; sides feebly arcuate, slightly convergent and nearly straight thence to the base; apex distinctly constricted; disk very slightly wider than the head, very slightly impressed in the middle near the base, finely and very densely punctate. Scutellum rather distinct, somewhat pointed. *Elytra* at the narrowly rounded and rather prominent humeri one-third wider than the prothorax; sides parallel, nearly straight, fully twice as long as wide; acute at apex; disk rather coarsely and feebly striate; striæ with rather coarse, feebly impressed, and approximate punctures, each bearing a minute, pale seta; intervals feebly convex, nearly smooth; setæ extremely sparse and not distinct. *Abdomen* convex; first suture broadly, rather feebly emarginate in a circular arc in the middle half; second segment nearly as long as the next two together; third longer than the fourth; rather densely clothed with recumbent squamose pubescence and with very long, slender, sparse, erect setæ. Anterior and middle tibiæ rather strongly sinuate internally near the apex. Cotyloid surfaces of the posterior tibiæ very oblique. Length 4.2 mm.

New Mexico (Fort Wingate 1).

The single representative of this very distinct and aberrant species I owe to the kindness of Dr. R. W. Shufeldt, who discovered it in the locality above indicated. It is the smallest species known within our faunal limits.

APPENDIX.

SITONINÆ.

SITONES Germ.

The genus Sitones consists of numerous species which are mutually rather closely allied, not only in general appearance, but in structure. The European forms have been well studied and appear to be much more abundant than the American, but whether this is an actual fact, or whether the disparity is due rather to the neglect of collection and observation on the part of our coleopterists, it would not be prudent to affirm at present. It is true, however, that on the Pacific coast, where the faunal conditions are more similar to those prevailing in Europe, the species are very abundant and distinctly characterized.

The causes of the neglect of our species by specialists in this country are, doubtless, their monotony and the great sexual differences in some species, which often render—as in Macrops—an accurate identification a matter of more or less doubt. In the western species, however, there are but two or three of those coming under my observation which possess these sexual divergencies, and there are many species in which the males and females are nearly alike.

To give a better idea of the number of our species, it may be well to state that I have been unable to identify among the numerous species here brought to notice either *californicus*, *seniculus* or *vittatus*, in the case of the last after an inspection of the LeConteau type. The second mentioned is so carelessly and inaccurately described by Mannerheim that it is doubtful if it can ever be recognized, the expression "cinereo-tomentosus," for instance, being perfectly foreign to any known species of Sitones in North America, for they are all distinctly squamose. My material from the Mississippi Valley is not sufficiently extensive to enable me to assign species to the names *indifferens* and *scissifrons* of Say, and this must be reserved until the genus can be monographically revised.

The parts which appear to vary most throughout the genus are the eyes and abdomen. In the former the inner margin is, in a number of species, strongly elevated and prominent, but in the majority they are normal and generally more or less elongate. The first ventral suture varies, being in some rather abruptly arcuate or acutely angulate in the middle, and in others very broadly rounded in the middle or angulate throughout the width; but this character does not permit of employment for purposes of classification, because of the many intermediate forms. The second ventral segment is generally nearly as long as the next two combined, but in several, and notably *flavescens*, it is much shorter. Other divergencies of structure or of vestiture will be alluded to below under the respective species and in the accompanying table. The claws are distinctly appendiculate.

I have been greatly aided in the identification of species by four European representatives very kindly communicated by M. Aug. Sallé, of Paris. These are *flavescens, crinitus, lineellus,* and *tibialis;* the last three are quite distinct from any native species which I have seen and probably do not occur here at all, except sporadically as a result of commercial intercourse.

As a rule, our species appear to be more slender and elongate than the European. The former, as far as known to the writer, may be classified as follows :—

Elytra without erect setæ; second ventral segment shorter; first tarsal joint longer.................................... ..**flavescens**

Elytra with distinct erect setæ, sometimes shorter, wider, and squamose.

Inner margin of the eye not prominent.

Prothorax not constricted near the apex, coarsely, sparsely, and very distinctly punctate; punctures of elytral striæ becoming rapidly very coarse and distinct toward base........**hispidulus**

Prothorax constricted near the apex, densely and indistinctly punctate; punctures of elytral striæ generally indistinct, and when evident, but very slightly and gradually coarser toward base.

Seventh joint of antennal funicle as long as wide, and, on the edge, longer than wide; eye very long, evenly elliptical, **extrusus**

Seventh funicular joint wider, transverse.

Elytra more or less tesselate, maculate, or vittate.

Elytral striæ evidently punctate.

Prothorax with a rather wide and very distinct median vitta.

Pronotal scales smaller, those of the median vitta narrow and elongate; elytra with the alternate intervals vittate ♂, or confusedly tessellate ♀; male very slender, female robust.................... ....**varians**

Pronotal scales longer, those of the vitta broader; elytra not vittate, but confusedly maculate..**margaritosus**

Prothorax without distinct median vitta.

Scales of head and prothorax cupreous; base and apex of the latter equal in width; color dark; punctures very distinct..................... .... **procerus**

Scales cinereous throughout; size larger; prothorax narrower at the apex than at the base......**occidentalis**

Elytral striæ not distinctly punctate (where normally squamose).

Alternate intervals of elytra not, or very feebly, elevated; form robust.

Dark setæ of elytra strigose, robust, and in the form of elongate, obtuse scales; white setæ broad, short, squamiform, and but slightly different in form from the much more numerous darker ones.

Color gray; elytra externally with a broad, white vitta; beak flat....... ....**eximius**

Color brown; elytra not vittate; beak broadly impressed..............................**montanus**

Dark setæ of elytra not strigose, in form cylindrical and pointed.

Dark setæ very short, subrecumbent and robust, **nebulosus**

Alternate intervals distinctly more elevated; form slender, **alternans**

Elytra uniform in tint, or very nearly so.

Dark brown, beneath pale reddish-brown; eyes small, scarcely longer than wide.............. ....**sordidus**

Gray, whitish beneath; eyes normal, distinctly longer than wide; prothorax short, very strongly and angularly arcuate at the sides ... .**osculans**

Inner margin of the eye prominent, and distinctly elevated above the flat surface of the front.

Beak and front sulcate.

Antennal scape much shorter than the funicle, and but slightly longer than the club.

Pronotal punctuation coarse and very deep; scales very sparse, scarcely obscuring the punctures..............**prominens**

Pronotal punctuation finer; scales denser, almost completely concealing the punctures.

Head coarsely punctate, with many minute punctures in the interspaces; sulcation shorter, wide, very deep; apical impression distinctly limited behind; prothorax constricted very near the apex.. ....**hispidiceps**

Head more finely, densely, and uniformly punctured; median sulcation fine, longer and less distinct; apical impression well limited at the sides but not behind; prothorax constricted at apical fifth.......................**angustulus**

Antennal scape about as long as the funicle, and fully one-half longer than the club.

Punctures of elytral series large and distinct.......**explicitus**

Punctures very small and not at all distinct.....**apacheanus**

Beak and front not sulcate; occiput having a very deep, somewhat elongate fovea in the middle and just behind the middle, of the eyes...**sparsus**

S. hispidulus Fab.—Gen. Ins. Mant., p. 226; Allard, Mon., p. 376.

The specimens which I have assigned to this species are shorter and more robust than usual in our fauna, although of a common European type.

I have been unable to compare them directly with European specimens, but, on account of the fact just stated, it is probable that their specific identity has been correctly determined. The specimens in my cabinet are from Pennsylvania, New Jersey, and Nebraska.

S. extrusus n. sp.—Form oblong, slightly depressed, very densely clothed with small, rounded scales, nearly uniform, dark-brown in color, but with a few white intermingled on the third and fifth intervals; small dark setæ very abundant, erect, long, and robust; larger white setæ distinct, sparsely distributed in single rows on the intervals; abdomen densely setose and squamose throughout. *Head* slightly wider than long; front flat; head and beak densely punctate, squamose, and setose; the latter about as long as wide, feebly carinate in the middle at apex, where it is also feebly impressed; frontal fovea deep, elongate; canaliculation at base of beak short, fine, and feeble; eyes large, elongate, antennal scape reaching the middle of the eye. *Prothorax* slightly wider than long, very slightly narrowed from base to apex; the latter both subtruncate; strongly constricted at one-sixth the length from the apex on the sides, the constriction posteriorly arcuate, and feebler on the disk, feebly constricted at the sides very near the base; disk evenly convex; sides feebly arcuate; surface finely, densely punctate; scales whiter at the sides, and with many small, semi-erect setæ toward the middle; median vitta not distinct. *Elytra* oblong, three-fourths longer than wide; sides parallel: disk four-fifths wider than the prothorax, finely

striate; striæ very finely and not distinctly punctate; fifth interval with a small, pale, yellowish spot at base. Length 6.5 mm.

Lower California (St. Julian 3). Mr. G. W. Dunn.

This species is peculiar in its more elongate seventh funicular joint and more elongate eyes. The tarsal claws are robust and strongly arcuate, each has a long, slender basal appendage, which character is generic, the appendage being in some species longer and in others shorter.

S. varians n. sp.—Slender, convex; scales cinereous, small, rounded, dense, sparser on the dark areas of the prothorax; base of head trivittate; prothorax distinctly trivittate, with pale, subcupreous scales, remainder piceous; alternate intervals of elytra pale and dark, giving a regularly vittate appearance; abdomen pale, squamose, and setose throughout. *Head* slightly wider than long, feebly conical; front flat; surface of head and beak coarsely, deeply, and densely punctate, rather sparsely squamose and with very short, robust, inconspicuous setæ; frontal fovea elongate, narrow, deep, prolonged anteriorly through the basal half of the beak in a fine channel; beak not as long as and distinctly narrower than the head, as long as wide, scarcely dilated at apex; surface broadly, feebly impressed, not impressed at apex; eyes large, broadly convex; antennæ moderate, piceous; scape rufous; first joint of funicle as long as the next two together, second longer than the third. *Prothorax* about as long as wide, cylindrical, broadly and feebly constricted at the sides near the apex. Sides broadly arcuate, feebly sinuate very near the base; apex and base equal, broadly and very feebly arcuate; disk evenly convex, rather finely, deeply, and densely punctate; punctures but slightly covered in the dark areas; minute setæ short and as dense as the scales. *Elytra* twice as long as wide, not one-half wider than the prothorax, acutely rounded at apex; sides parallel and nearly straight; disk convex, finely and feebly striate, striæ finely punctate; intervals alternately slightly broader and narrower, feebly convex; dark setæ moderately numerous, small; longer pale setæ very sparse, wanting near the suture toward base; dark scales of narrower intervals not so dense as those of the wider pale intervals; scales all finely, deeply, and very distinctly strigose. *Legs* moderate, piceous; tarsi and sometimes the tibiæ paler rufous. Length 3.8–5.0 mm.

California (Humboldt Co.—Hoopa Val., Arcata, Hydesville).

The above description is taken from the male, which is much smaller and more slender than the female. Of the thirteen specimens before me, there are four males, and of these the type is the only one exhibiting the vittate elytra with any degree of distinctness. The females have the elytra very indefinitely vittate or confusedly maculate, and have a more transverse pro-

thorax. In one of the males, the prothorax is distinctly smaller, shorter, and more strongly rounded at the sides. There may be several varieties indicated by these characters, but they are too indefinite to describe.

This species is larger, more slender, and more sparsely squamose than *vittatus* Lec.

S. margaritosus n. sp.—Rather slender; integuments black; scales sparse, large, pure pearly white and pale brown confusedly intermingled in small nebulous patches, subvittate at the sides and middle of the pronotum, rather sparsely placed, being distinctly separated over the entire surface, rounded, coarsely and strongly strigose, sparse on the abdomen which is more densely setose. *Head* small, slightly transverse, feebly conical; eyes large, at less than one-half their length from the base; surface of head and beak flat, finely, densely punctate, uniformly covered with large, conspicuous, white, and feebly embrunate scales, except a large, angulate, feebly impressed area at the apex of the beak which is not squamose, but covered with the short, pale, robust setæ which are also distinct over the entire surface; median groove very fine, feeble, and inconspicuous; antennæ rather short; first joint of funicle distinctly more robust, slightly longer than the next two together, the latter small, subequal in length. *Prothorax* widest at the middle, distinctly wider than long; sides distinctly and evenly arcuate in the middle, convergent and straight to the base, equally convergent and feebly sinuate toward apex; apex truncate; base equal in width, feebly arcuate; disk convex, coarsely, very deeply, and densely punctate, the punctures obscured by the scales; dark areas densely covered with short, robust, pale brown setæ; pale vittæ with a very few similar pure white setæ. *Elytra* nearly twice as long as wide, not one-half wider than the prothorax, acutely rounded at apex; sides parallel, nearly straight; disk convex, feebly striate; striæ with moderately coarse, but slightly distinct punctures; intervals feebly convex, slightly unequal in width; small, pale brown setæ rather dense, long, erect; white setæ very sparse, wanting toward the base and suture. Length 4.0 mm.

California (Santa Cruz and Monterey Cos. 2).

A very distinct species by reason of the large pearly, sparsely placed scales. The punctures of the elytral striæ are but slightly distinct, except when the easily abraded scales are removed.

According to the description given by Fahrens, this species appears to resemble *californicus* more closely than any other, but the scales are large and sparse, and the expression "cinereotomentosus" cannot be properly applied. The scutellum moreover is not concolorous, but white.

S. procerus n. sp.—Elongate, convex; scales very dark brown,

third and fifth elytral intervals slightly maculate with paler, sides of pronotum paler, median vitta not distinct; abdomen very densely squamose and setose throughout, slightly paler; scales of upper surface small, oval, slightly longer than wide, convex, excessively finely, feebly, and indistinctly strigose. *Head* slightly transverse; surface of head and beak flat, densely punctate, sparsely squamose, densely covered with bristling setæ; scales sparser, smaller, and cupreous toward apex; beak robust, shorter than the head, distinctly wider than long, finely carinate above at each side, feebly subcarinate in the middle at apex; frontal fovea narrow, deep, elongate, attenuate anteriorly, becoming obsolete before attaining the middle of the beak; eyes very large, feebly convex, much longer than wide; antennæ moderate; first joint of funicle distinctly more robust, as long as the next two together, second longer than the third. *Prothorax* very slightly wider than long, cylindrical, widest distinctly before the middle, where the sides are very feebly arcuate, thence feebly convergent and straight to the base, abruptly, finely, and distinctly constricted at the sides at apical sixth; apex and base equal, the former subtruncate, the latter very feebly arcuate; disk convex, rather coarsely, deeply, and densely punctate; fine, short, dark setæ rather numerous toward the middle; median vitta represented by a very narrow, feebly defined single line of slightly paler scales. *Elytra* twice as long as wide, acutely rounded at apex, not one-half wider than the prothorax; sides parallel, straight; humeri slightly oblique; disk convex, finely striate; striæ rather coarsely, deeply and very distinctly punctate throughout; intervals nearly equal, almost flat; dark setæ numerous, erect, fine and capillary; white setæ very sparse, distinct. Unguicular appendage fine, long, distinct and setiform. Length 5.0 mm.

California (Napa Co. 1).

Easily distinguishable by its narrow elongate form, dark brown color, and very distinct elytral punctures, these being more distinct by far than in any other species of this group, except *hispidulus*. In general characters it resembles the *prominens* group, and notably *explicitus*.

S. occidentalis n. sp.—Elongate; elytra somewhat robust and depressed, densely clothed with small, rounded, cinereous scales, variegated with maculæ of pale brown on the third, fifth and seventh elytral intervals; scales smaller, arranged transversely and very much sparser on the median portions of the pronotum; abdomen densely setose and squamose, the male with a denuded spot at apex. *Head* distinctly transverse, rather large; eyes large, oval, rather convex; front and beak flat, rather finely and densely punctate, rather sparsely and finely squamose and thickly bristling with conspicuous, erect, whitish setæ; lateral and apical carinæ of beak feeble; frontal fovea fusiform, deep,

furrow not attaining the middle of the beak; the latter robust, distinctly shorter than the head, slightly wider than long; antennæ moderate; first joint of funicle scarcely as long as the next two combined, second distinctly elongate. *Prothorax* slightly wider than long, widest in the middle; sides feebly arcuate, thence feebly convergent and nearly straight to the base, finely, deeply constricted at the sides at anterior sixth; apex truncate, distinctly narrower than the base; the latter very feebly arcuate; disk slightly flattened above, finely, densely punctate; pale brownish setæ, dense toward middle and directed transversely. *Elytra* oblong, three-fourths longer than wide, more than three-fourths wider than the prothorax, acutely rounded behind; sides parallel and nearly straight; roundly and rather strongly emarginate at base, finely and rather feebly striate; striæ with moderate rather distant punctures. intervals subequal, rather feebly convex; pale brown setæ very abundant, rather long, fine and capillary; erect white setæ very sparse, and but slightly longer than the darker ones. Length 6.0 mm.

California (Healdsburg, Sonoma Co. 2).

This fine species is remarkable in the total absence of a median pronotal vitta, in its large size, comparatively distinct elytral punctures, and pale cinereous color, with the alternate intervals laterally, distinctly, but unevenly tesselate with pale brown. It is the species identified as *californicus* by LeConte, but this determination is probably erroneous, because of the absence of the median vitta, a prominent character of *californicus*.

S. eximius n. sp.—Form elongate, convex; scales moderate or rather large, oval, slightly longer than wide, finely and distinctly strigose and flat, densely placed although not overlapping, sparse on the dark areas of the pronotum, generally whitish, especially in a broad, indefinite line from each humerus to the sutural portions of the elytral apex; sutural portions of disk feebly maculate with pale brown, and a broad vitta on each flank of the same tint; pronotum distinctly trivittate. *Head* moderate, slightly transverse; occiput feebly convex; front and beak flat, finely, densely, and deeply punctate, densely squamose; scales much longer than wide; setæ short, robust, and not conspicuous; median groove fine but distinct, slightly expanded on the front and attaining the middle of the beak; the latter nearly as long as the head, very slightly wider than long; eyes rather small, feebly convex; antennæ moderate; first joint of funicle slightly longer than the next two together, the latter subequal and both slightly elongate. *Prothorax* nearly one-third wider than long; sides distinctly arcuate, nearly straight toward base, very finely constricted at the sides at less than anterior sixth; apex very slightly narrower than the base, subtruncate; base broadly and feebly arcuate; disk convex, finely, densely punctate; setæ of dark areas very short and robust; median vitta broad and distinct,

and broadly, very feebly impressed. *Elytra* four-fifths longer than wide, gradually, acutely rounded behind from the middle, about three-fourths wider than the prothorax, deeply, roundly emarginate at base; sides straight and parallel near the base; disk convex, finely, feebly striate; striæ with small occult punctures; intervals slightly unequal, feebly convex; dark setæ very short, robust, squamiform and sparse; white setæ very sparse, short, robust, and not distinct. *Abdomen* convex toward base, densely squamose and with very short fine setæ. Length 5.0–6.0 mm.

Nevada (Washoe Co. 4).

One of the most distinct species of the genus in size, markings, and nature of the vestiture. The description is taken from the male; the female is slightly more robust and has the elytra relatively slightly broader and shorter.

S. montanus n. sp.—Form rather robust, convex; scales brown, scarcely perceptibly variegated in tint, oval, slightly longer than wide, dense and overlapping, the prothorax broadly and strongly trivittate with whitish scales; abdomen densely squamose and very sparsely setose, the scales elongate and acicular. *Head* short, robust, transverse; front flat, broadly impressed near each eye; surface squamose, densely punctate, and with short robust setæ; beak slightly shorter than the head, distinctly transverse, broadly, feebly impressed, the sides being slightly declivous toward the median groove, which is deep, narrow and distinct, foveate on the front; eyes moderate, slightly convex; antennæ short; first joint of funicle robust, distinctly longer than the next two together, second longer than the third. *Prothorax* slightly wider than long; sides rather strongly arcuate, finely constricted at apical sixth and very distinctly so at basal tenth; apex very slightly narrower than the base, both subtruncate; disk convex; median vitta broadly, feebly impressed, dark areas densely clothed with short, piceous, robust squamiform setæ. *Elytra* three-fourths longer than wide, gradually narrowed behind from near the middle, acutely rounded at apex, deeply emarginate at base; sides parallel and nearly straight toward base; disk convex; striæ fine, distinctly impressed; punctures very fine and occult, close; intervals convex, alternately slightly more strongly so toward base; dark setæ erect, robust, short and squamiform, abundant; the pale setæ but slightly longer, robust, squamiform and very sparse. *Abdomen* convex; second ventral segment in the middle as long as the next two together. Length 5.3–5.7 mm.

California (Placer Co. 2).

Related to the preceding, but differs in its shorter, more robust form, darker colors, and much denser dark setæ of the elytra.

S. nebulosus n. sp.—Form robust, convex; scales moderate in size, obtusely oval, finely, feebly strigose, thin, slightly overlapping on the elytra, pale brownish-cinereous, variegated with small spots of piceous-brown in which the scales are sparser, but the small, dark setæ more abundant, and especiably obvious on the alternate intervals; pronotum with the sides and a distinct median vitta paler; abdomen cinereous with very dense scales and setæ. *Head* moderate, very slightly wider than long; eyes moderate, at two-thirds their length from the base; front and surface of beak densely squamose and with numerous short, robust, erect setæ; beak distinctly shorter than the head, about as long as wide; surface broadly impressed; median groove long, very fine; frontal fovea elongate, narrow; antennæ piceous: first joint of funicle robust, slightly longer than the next two together, second very slightly longer than the third, both slightly longer than wide. *Prothorax* slightly wider than long; sides broadly, evenly arcuate, finely constricted near the base and apex; the latter broadly arcuate, slightly narrower than the base; the latter subtruncate; disk convex, finely, very densely punctate; punctures nearly concealed; dark setæ brown, robust, numerous. *Elytra* about two-thirds longer than wide and three-fourths wider than the prothorax; humeri rather prominent, the sides being feebly sinuate for a very short distance behind them; sides nearly parallel or excessively feebly convergent, and almost straight in basal two-thirds, then acutely rounded behind; base roundly emarginate in the middle; disk convex, finely striate; striæ impressed, finely, closely, and obscurely punctate; intervals slightly unequal, rather unevenly convex; dark setæ rather abundant, especially dense in widely separated nuclei on the alternate intervals, short, robust, and inclined; pale setæ as usual, sparse, long, erect, and nearly three times as long as the darker ones. Length 5.0 mm.

California (San Diego 1).

Especially remarkable in abdominal structure, the last three sutures being much more than usually bisinuate and posteriorly angulate at the sides; the first suture has has a small, rounded, rather abrupt, and deep median sinuation, and in the middle, the second segment is fully as long as the next two combined. The species is easily distinguishable by its unusually robust form, rather prominent humeri, and very short, robust, dark setæ of the elytra. The seventh funicular joint is as long as wide on the edge, but slightly transverse on the compressed side.

S. alternans n. sp.—Form rather slender, convex, dark plumbeous-gray with brown indiscriminately intermingled and not definitely tesselate; pronotum slightly paler at the sides and with a wide median vitta which is but very slightly paler; scales rather large, much larger on the pronotum, rather densely placed, but not overlapping, rounded

or subtruncate, very coarsely, deeply, and distinctly strigose; abdomen gray, more sparsely squamose and setose. *Head* and beak finely and densely punctate, densely squamose, and with numerous, robust, erect setæ, flat; median groove fine; beak slightly wider than long; antennæ short, robust, rufous; first joint of funicle much more robust, much longer than the next two together, two to four short, subequal, moniliform, second very slightly the longer. *Prothorax* widest slightly before the middle, one-fourth wider than long; sides feebly arcuate, feebly convergent and nearly straight toward base, feebly sinuate near the apex; the latter subtruncate, scarcely narrower than the base; disk convex, densely punctate; dark setæ short and very robust; scales nearly all pale, but more sparse on the dark areas. *Elytra* four-fifths longer than wide, less than one-half wider than the prothorax; sides straight and parallel, broadly rounded from just behind the middle and acutely rounded behind; disk convex, finely striate; striæ finely and not distinctly punctate; intervals convex, the alternate ones distinctly more strongly so; dark setæ extremely short, robust, and not very numerous; pale setæ very sparse, short, and robust, nearly twice as long as the darker ones. Length 4.0 mm.

California (exact locality unknown 1).

A small and rather obscure species, but which may possibly be recognized by the large, deeply strigose, pronotal scales, nearly uniformly pale in color, but much sparser in the dark vittæ, and by the elytral intervals being alternately decidedly more strongly elevated. The abdominal scales are elongate, finely strigose, and simple near the base, but only one-half as long, smaller, oval, and feebly plumose near the apex.

S. sordidus Lec.—Rather robust; scales dark-brown throughout, small, oval, very finely and indistinctly strigose on the elytra, more coarsely so on the pronotum, dense but not overlapping, thick, and slightly convex; abdomen densely squamose and setose. *Head* moderate, slightly transverse; eyes rather small, very slightly longer than wide, at nearly their own length from the base; front flat, very feebly impressed laterally, very densely squamose and with fine, short, inconspicuous setæ; median groove narrow and deep; beak nearly as long as wide; scrobes not visible from above; apex broadly, angularly impressed, densely punctate, sparsely setose, and finely squamulose; antennæ moderate; first joint of funicle slightly longer than the next two together, second elongate. *Prothorax* rather distinctly wider than long, widest just before the middle; sides distinctly arcuate, distinctly sinuate near the apex, and more broadly and feebly so near the base; apex very slightly narrower than the base, both very broadly and feebly arcuate; disk convex, finely, densely, deeply punctate, the sides not distinctly paler, and the median vitta scarcely distinguish-

able; dark setæ extremely short, robust, and rather sparse. *Elytra* about three-fourths longer than wide, nearly two-thirds wider than the prothorax; sides in basal two-thirds parallel and very feebly arcuate, thence convergent and narrowly rounded at apex; disk finely striate; striæ with small, not very close, rather indistinct punctures; intervals very feebly convex, slightly unequal; dark setæ very small, short; robust, and sparse, aggregated occasionally in dense clusters on the alternate intervals, there being rarely more than one or two on each interval; white setæ very sparse, rather slender and more than twice as long as the darker ones. *Abdomen* broadly convex; first suture broadly, feebly angulate throughout its width, the apex of the angle rounded; second segment in the middle slightly shorter than the next two together. Length 4.8 mm.

California (San Francisco 1).

This specimen, which agrees well with the original type, is probably a male, as there is a small, partially denuded spot near the apex of the last ventral segment.

S. osculans n. sp.—Rather slender; scales rather large, deeply and strongly strigose, dark plumbeous-gray, slightly paler at the sides of the prothorax, but not in the middle; abdomen more sparsely squamose, setose. *Head* and beak rather wide and robust, flat, densely punctate, rather sparsely squamose, and with many short, robust, bristling setæ; apex of beak not at all squamose, sparsely setose; median furrow fine and distinct; eyes large, moderately convex; antennæ moderate, dark rufous; first joint of funicle rather slender and nearly as long as the next three together, second very slightly longer than the third, third and fourth equal, very slightly longer than wide. *Prothorax* two-fifths wider than long, widest in the middle, where the sides are inflated and strongly subangularly arcuate, very feebly and finely constricted on the sides just behind the apex, nearly straight toward base; apex and base subequal, very broadly and feebly arcuate; disk convex; median vitta very feeble and not distinct; surface densely punctate; dark setæ pale-brown, rather long and slender and rather conspicuous. *Elytra* three-fourths longer than wide; sides parallel and nearly straight in basal two-thirds, thence rapidly and parabolically rounded at apex; base broadly, strongly emarginate; disk convex, about one-half wider than the prothorax, finely, feebly striate; punctures rather coarse, feeble, and indistinct; intervals subequal, nearly flat; dark setæ pale brown, rather long moderately robust, very abundant and conspicuous, especially on the alternate intervals; white setæ very sparse and rather short, about one-half longer than the dark ones. *Abdomen* broadly convex; first suture broadly, rather strongly arcuate in the middle. Length 4.3 mm.

California (Hoopa Valley, Humboldt Co. 2).

Although rather closely allied to *margaritosus*, I believe that the present species is distinct, on account of the shorter, more transverse, and more strongly inflated prothorax, with the scales more evenly arranged, and without distinct median vitta, and also because of the denser, paler, and more conspicuous dark setæ of the elytra.

We arrive here at a division of the genus which is characterized by the elevated internal margin of the eye. There are other characters which serve to distinguish these species, such as the sparser scales on the head and beak, enabling the punctures to be more distinctly seen, and also the more decided impression at the apex of the beak. The form is generally elongate and slender. This section should probably include *procerus*, but as the internal margin of the eye is so feebly elevated as to give rise to uncertainty, it is left, for the present, with the preceding division.

S. prominens n. sp.—Slender, convex; scales small, oval, those on the elytra rather dense, but not at all overlapping, obscurely and finely strigose, those of the head and prothorax very sparse, and a little more distinctly strigose and more cupreous; general color pale brown, slightly variegated with cinereous, especially near the sides; pronotum very feebly and indefinitely trivittate. *Head* slightly transverse; front and base of beak flat, rather coarsely, deeply, very densely, and irregularly punctate; the punctures large and small intermingled; surface rather sparsely bristling with long fine dark setæ and shorter paler ones intermingled, almost devoid of scales, except a very few near the eyes and base; eyes large, feebly convex, inner margins very strongly elevated above the front; beak slightly transverse, nearly as long as the head; apex slightly impressed, feebly declivous and finely tricarinate; lateral carinæ convergent and rather discal; median groove rather narrow and deep; antennæ with first joint of funicle as long as the next two together, second elongate. *Prothorax* slightly wider than long, cylindrical, rather broadly and feebly constricted at apical fifth, and very finely so just before the basal margin; intermediate portion of the sides broadly, distinctly, and nearly evenly arcuate; base and apex equal, just visibly arcuate; disk coarsely, deeply, and densely punctate; scales not obscuring the punctures; dark setæ very fine and not dense. Scutellum small, extremely densely squamose, whitish. *Elytra* fully twice as long as wide, nearly one-half wider than the prothorax; sides straight and parallel in basal two-thirds, acutely roundly behind, the sides being very feebly sinuate before attaining the apex; disk convex, feebly striate; striæ with small, but distinct and rather approximate punctures; intervals nearly flat, subequal; dark setæ abundant, robust,

very finely attenuate, arcuate; pale setæ short, very sparse, scarcely twice as long as the darker ones; each elytron has a small, subapical umbo on which the dark setæ are extremely dense. Length 3.5–4.0 mm.

California (San Diego 2).

The second ventral segment is much shorter than the next two combined, and the base of the abdomen is broadly and feebly impressed; surface densely squamose throughout; first suture broadly and feebly arcuate in the middle.

S. hispidiceps n. sp.—Form elongate, convex; scales moderate, rounded, truncate, finely but distinctly strigose, cinereous at the sides, indefinitely clouded with pale brown toward the suture, dense, but seldom overlapping on the elytra. *Head* small, robust, distinctly wider than long; front and basal half of beak flat, coarsely and deeply punctate, with finer punctures on the interspaces, bristling with long erect setæ, and shorter, paler, more recumbent ones near the surface; the latter almost devoid of scales, except near the eyes; beak as long as the head, slightly wider than long, feebly declivous and distinctly impressed at apex, the impression divided as usual by a distinct carina; lateral carinæ fine and strongly elevated; impression distinctly limited behind by a more declivous surface; eyes large, inner margin rather distinctly elevated; antennæ rufous, rather slender, nearly as in *prominens*. *Prothorax* distinctly wider than long, cylindrical; base and apex equal, very feebly arcuate; sides rather distinctly constricted very near the apex, broadly and feebly arcuate in the middle; disk convex, rather finely and densely punctate: scales rather dense, obscuring the punctures, but sparser than those of the elytra, not forming distinct vittæ; setæ pale brown, rather long, fine and dense, especially toward the median line. *Elytra* fully twice as long as wide, formed nearly as in *prominens;* subapical umbones feebler; disk feebly striate; striæ finely and not very distinctly punctate; intervals subequal, nearly flat; setæ as in *prominens*. *Abdomen* impressed in the middle at base. Length 4.5–4.8 mm.

Arizona (exact locality not given 2).

This species greatly resembles the last in outward form, but differs very remarkably in its larger, less elongate-oval, and very much more coarsely and distinctly strigose scales, by the denser scales of the prothorax, and finer pronotal punctuation. The punctures of the elytral striæ are much less distinct, and the color of the vestiture is more whitish and less brown.

S. angustulus n. sp.—Form elongate and rather slender, convex; scales pale brownish-gray, feebly variegated with cinereous at the sides,

small, dense, rounded, finely and not very distinctly strigose on the elytra, longer and more deeply strigose on the pronotum, which is feebly trivittate. *Head* distinctly wider than long; front and base of beak flat, rather finely, very densely and deeply punctate; scales distinct in two spots in the middle near the base, and in an arcuate line on each side from the base along the eye and across the base of the beak, elsewhere devoid of scales, except a few sparse cupreous ones scattered over the apical impression of the beak; surface bristling with erect setæ which are rather dense and uniform in color; median sulcus deep, but narrow; eyes large, inner margin very distinctly elevated; beak scarcely as long as the head, wider than long, apical impression short, slightly declivous and feeble, carinæ feeble and short, impression not at all distinctly limited behind; antennæ rather slender; basal joint of funicle as long as the next two together, two to four distinctly elongate, second slightly the longer. *Prothorax* cylindrical, slightly wider than long, distinctly constricted at apical sixth, and more finely so just before the basal margin; intervening sides broadly and distinctly arcuate; apex and base equal, the former subtruncate, the latter very feebly arcuate; disk finely, densely punctate, rather densely squamose; setæ long, fine and abundant. *Elytra* about four-fifths longer than wide, not one-half wider than the prothorax; sides in basal two-thirds straight and parallel, thence rather acutely rounded behind, the sides before the apex very broadly and feebly sinuate; each elytron with a very minute feeble subapical umbo; disk convex, finely, feebly striate; striæ with very fine, but rather distinct approximate punctures; intervals subequal, nearly flat, dark setæ rather dense, fine, attenuate; pale setæ sparse, and but slightly longer. Length 5.3 mm.

California (Monterey, Monterey Co. 1).

The fine setigerous appendage of the ungues is distinct and sometimes gives the appearance of a finely cleft claw. This type specimen, although a female because of the unimpressed abdomen, is apparently distinct in its punctuation and vestiture.

S. explicitus n. sp.—Elongate, convex; scales moderate in size, rounded, very dense and overlapping on the elytra, more sparse on the pronotum where they do not obscure the punctures, equal in size on the elytra and pronotum, piceous in color, finely and closely strigose; pronotum not at all vittate except at the base, where there are three small paler spots; abdomen very densely setose and squamose, scales dark gray, distinctly plumose toward apex. *Head* slightly transverse, about equal in length to the beak; the latter slightly wider than long; front and basal half of beak nearly flat, coarsely, very densely, and deeply punctate, only squamose near the eyes, and with a few small cupreous scales at the apex of the beak; surface covered with a confused mass of setæ, rather fine, some cinereous and others subcupreous; median

groove very deep, wide, and conspicuous; eyes large, inner margin slightly elevated; beak with large lunate impression in apical half, the sides carinate, median carina in the form of an elongate tubercle; antennæ slender, slightly longer than usual, piceous-black; first joint of funicle distinctly longer than the next two together, second to fourth elongate, the former much longer than the third. *Prothorax* cylindrical, distinctly wider than long, with a rather abrupt, distinct constriction at apical sixth; sides broadly, subangularly arcuate; disk convex, rather finely and densely punctate; punctures deep, generally separated by their own widths; setæ small, piceous, abundant, but not conspicuous; base and apex equal, broadly and very feebly arcuate. *Elytra* four-fifths longer than wide; sides parallel and straight in basal two-thirds; disk moderately convex, rather distinctly striate; striæ with round, deep, and very distinct punctures, usually separated by nearly twice their own diameters; intervals subequal, nearly flat; dark setæ rather large, robust, rapidly and finely attenuate, very abundant, piceous and not conspicuous; pale setæ rather abundant and twice as long as the darker ones. First abdominal suture broadly and subangularly emarginate throughout its width; second segment slightly shorter than the next two together; setæ white, very dense and unusually conspicuous. Length 5.3 mm.

California (San Diego 1).

This species is remarkably distinct from all the others here described, in its dark, piceous vestiture, longer antennal scape, and distinct elytral punctures. It is described from the female.

S. apacheanus n. sp.—Somewhat robust and flattened above; scales rather large, rounded, finely, distinctly strigose, very dense, overlapping, dark brown and paler confusedly intermingled, presenting a feebly tesselated appearance on the alternate intervals; pronotum with narrow, feeble median vitta, and slightly paler sides; abdomen whitish, very densely squamose and setose, the scales elongate and finely plumose. *Head* rather robust, distinctly transverse; front flat; surface of head and beak coarsely, very sparsely squamose in the middle; more densely so laterally, densely bristling with fine, erect setæ; median groove fine but deep; beak shorter than the head, wider than long; basal half on same plane as the front, but broadly and feebly impressed; apex feebly declivous and impressed, feebly carinate in the middle, sparsely, finely squamose, and more sparsely setose; lateral carinæ more distinct than usual, also more discal and distinctly convergent from apex to base; scrobes more than usually visible from above; antennæ moderate; first joint of the funicle one-third the length of the latter, slender, as long as the next two together, second elongate, much longer than the third, third and fourth subequal, both elongate, five to seven shorter, strongly incrassate. *Prothorax* cylin-

drical, distinctly wider than long; sides rather strongly and evenly arcuate in the middle, sinuate near base and apex; the latter equal, apex subtruncate, base feebly arcuate; disk convex, rather coarsely, very deeply and densely punctate; punctures partially concealed, dark setæ fine, rather long and abundant. *Elytra* oblong, nearly twice as long as wide, four-fifths wider than the prothorax; sides nearly parallel and straight, acutely rounded behind from apical third; disk finely, feebly striate; striæ finely, rather closely and not distinctly punctate; intervals subequal, nearly flat; dark setæ rather long and fine, abundant; pale setæ very sparse, about one-half longer than the dark ones. Length 6.3 mm.

Arizona and Southern California 2. Mr. G. W. Dunn.

This species is the largest of the present group; the locality is subject to a little doubt, as both specimens may be from either Southern California or Arizona.

S. sparsus n. sp.—Form slender, convex, piceous; scales very small, elongate-oval, evenly and very sparsely distributed over the surface of the elytra, always separated by at least their own dimensions, very sparse on the prothorax, except in a small median basal spot where they are dense: throughout they are of the same color as the body and are extremely inconspicuous, very sparse on the abdomen; the latter more densely setose. *Head* conical, very slightly wider than long; front flat, slightly depressed below the inner margins of the eyes, not sulcate, but having a deep elongate median fovea just behind the middle of the eyes; the latter large and very feebly convex; entire surface of head and beak extremely densely, rather finely and very deeply punctate, sparsely squamose, and more densely setose; setæ short and rather robust; beak slightly wider than long, broadly, roundly, and very feebly impressed throughout its width, finely subcarinate at the sides, not at all impressed near the apex, the median carina entirely obsolete; antennæ rather short; basal joint of funicle more robust, nearly as long as the next two together, second longer than wide and slightly longer than the third. *Prothorax* cylindrical, very slightly wider than long; sides evenly and distinctly arcuate, feebly constricted near the apex; base and apex equal, very feebly arcuate; disk coarsely, deeply, and densely punctate; scales extremely sparse, except along the middle, where they are more numerous; setæ short, robust, rather numerous. *Elytra* about twice as long as wide, scarcely more than one-third wider than the prothorax; sides parallel and straight in basal two-thirds; disk convex, rather coarsely but feebly striate; striæ with rather coarse, very deep, and somewhat approximate punctures, distinctly more feeble toward apex: intervals slightly unequal, not distinctly convex; dark setæ short, robust and rather sparse; pale setæ very sparse, short and robust, about twice as long as the darker. *Abdomen* rather distinctly and

coarsely punctate; first suture rather broadly, strongly, and subangularly arcuate in the middle; second segment distinctly shorter than the next two combined. Length 3.5 mm.

California (Hoopa Valley, Humboldt Co. 1).

In vestiture and cephalic structure, this is one of the most aberrant species of the genus; it is also the smallest in our fauna. The antennal club is slightly less elongate than usual, and more robust. It is described from the male.

XIII.—*Notes on the Fishes of Cayuga Lake Basin.*

BY SETH E. MEEK.

Read April 16th, 1888.

During the year 1885–6, as a Fellow in Cornell University, Ithaca, N. Y., I spent some time in the study of the fishes of Cayuga Lake and vicinity. In the following paper is given a list of the fishes known in this region, together with such notes as seem proper. The material which forms the basis of this paper is chiefly in the museum of Cornell University. Some of this material was collected in former years by Dr. Wilder and Professor Gage, and by friends of the University; the rest for the most part by myself, aided by Prof. Gage and Prof. Comstock, also by students from time to time; of these, Mr. Harry Summers and Mr. G. D. Harris deserve special mention. Dr. Wilder employed a fisherman to aid me for a few days. To those students who assisted me, I acknowledge my indebtedness. I am also under many obligations to Dr. Wilder, Prof. Gage, and Prof. Comstock, for their kind assistance and encouragement, and especially to the first named for notes and other aids.

The completion of this paper has been very much retarded by causes apparently uncontrollable.

The collecting at the northern end of the Lake, at Cayuga and Montezuma, was delayed until late in the spring of 1886, and until only a few days before I was called away. I was unable, at the time, to make a careful study of that collection. Since then, I have been prevented, either by other duties or by separation from my notes or specimens, from completing the paper previously to this date.

It is to be hoped that the following list will be found approximately correct, and that the results of my labors may aid some one to undertake the work and give it a more extended and careful study. It will be a pleasure to me to aid any student who may attempt this research.

To Dr. Jordan, and especially to Prof. Gilbert, I am indebted for aid in identifying doubtful species. Mr. H. V. Kipp, of

Montezuma, N. Y., has kindly furnished some valuable notes which are included in the paper.

The classification is that adopted by Dr. Jordan.

Family I. PETROMYZONTIDÆ.

1. AMMOCŒTES BRANCHIALIS Linnæus.

Ammocœtes niger * A., 349. B., 9.

Ammocœtes æpypterus. C., 4.

This species, no doubt, inhabits most of the streams and lakes in the North Eastern United States, although only known at present from Indiana, Wisconsin and Ithaca, N. Y.

On May 8th, 1886, Professor Gage[1] and myself caught five specimens in Cayuga Lake Inlet. We saw as many more, but were unable to capture them. On May 22d we visited the Inlet a second time, but failed to find other examples of this species.

The five specimens were compared by us with other specimens from Indiana. In those from the Inlet, the extreme mandibulary cusps on either side were much longer than the four remaining cusps; all the cusps were pointed. In the specimens from Indiana the cusps were all bluntish and subequal in length ; no other differences could be detected. We consider this difference too small to be of specific value.

The five specimens from the Inlet were all males, and each was busily engaged in building his nest.

The habits of this species seem to be similar to those of the next species ; they ascend the Inlet to spawn about two weeks earlier, and in smaller numbers.

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* The references are as follows :—

A. Jordan's Manual of Vertebrates, 4th Edition.

B. Jordan and Gilbert, Synopsis Fishes N. A., 1882.

C. Jordan, Catalogue Fishes N. A., 1885.

Figures refer to pages in the above-named works.

"*" Indicates that the adult of the species is a food-fish.

"†" Indicates that the adult of the species is used as food by some of the larger fishes.

[1] Proc. Amer. Assoc. Adv. Sci., Buffalo meeting, page 269.

2. PETROMYZON MARINUS * Linnæus.

(Sea Lamprey: Large Lake Lamprey.)

A., 348. B., 11. C., 4.

Petromyzon nigricans. A., 349. B., 12.

This lamprey is found in much larger numbers than the preceding; it also reaches a much larger size.

During the spring of 1886, more than one thousand specimens were taken from Cayuga Lake Inlet, and all of them within five miles of Ithaca. They began to ascend the inlet, for the purpose of spawning, on May 21st, and continued to do so until late in June.

Their nests are excavations màde in the bed of the stream, where the water is shallow, and usually just above ripples. In the fine sand and gravel at the bottom of these nests, eggs are deposited by the females, and the embryos developed. The larvæ live in the sand along the edge of the stream, just below the water-line.

This species is frequently taken by the fishermen. It is usually found attached to the bull-heads, suckers, and other large soft-rayed fishes. It seldom attacks the spiny-rayed fishes.

The following count was made of a number of the lampreys which were caught during the spawning season and brought to the University by fishermen, within two weeks:

May 21st,	156	males and		69	females.
" 25th,	132	"	"	110	"
Later,	106	"	"	37	"
"	86	"	"	49	"
Total,	480	males and		265	females.

Length of longest male specimen,				42 cm.
"	" shortest	"	"	23 cm.
"	" longest female	"		35 cm.
"	" shortest	"	"	25 cm.

One small female, 18 cm. in length, was captured; the ova in it were quite immature.

During the spring a crest is developed upon the back of the male, between the nape and the dorsal fin; a similar crest is developed upon the ventral surface of the female, between the vent and the caudal fin.

The crest on the male was first noticed by Dr. B. G. Wilder, in 1875, and was then considered to be characteristic of the males of Cayuga Lake, and made the basis of a new species.

The crest has since been found characteristic of specimens from the Atlantic slope. It is said by Seeley to be a feature of European specimens, during the breeding season. The crest is seasonal and sexual, and, so far as I know, is characteristic of this species only. During other seasons of the year, the difference between the sexes of this fish is not easily, if at all, recognizable.

Family II. ACIPENSERIDÆ.

3. ACIPENSER RUBICUNDUS* Le Sueur.

(Sturgeon.)

A., 345. B., 87. C., 13.

A large specimen of this species, now in the museum of Cornell University, is reported as being from Cayuga Lake.

Mr. Seth Green informs me that sturgeons have occasionally been taken in Cayuga Lake; but, so far as he knows, they have never been found in any other of the small lakes of Central New York.

I copy the following extract from a letter of recent date from Mr. H. V. Kipp, Montezuma, N. Y.:

"There have not been any *sturgeons* taken from Cayuga Lake since 1880, but quite a number before that date, and the largest known weighed thirty-five pounds."

Family III. LEPIDOSTEIDÆ.

4. LEPIDOSTEUS OSSEUS Linnæus.

(Gar-pike Bill-fish.)

A., 342. B., 91. C., 13.

Occasionally taken from the northern end of the Lake. Not as numerous as they used to be (Kipp).

Family IV. AMIIDÆ.

5. AMIA CALVA Linnæus.

(Dog-fish), (Bow-fin), (Wave-fin.)

A., 340. B., 94. C., 13.

Seldom taken near Ithaca; not common at the northern end of the Lake.

Family V. SILURIDÆ.

6. NOTURUS GYRINUS † Mitchill.

(Stone-Cat.)

A., 337. B., 98. C., 14.

I have no knowledge of this species as being taken near Ithaca. There are a few specimens in the Museum of Cornell University from the Lake, but no definite locality is given. Several were taken by Mr. Harris and myself from a small stream near Montezuma.

7. AMIURUS NEBULOSUS * Le Sueur.

(Bull-head.)

C., 14.

Amiurus catus. A., 332. B., 104.

Very abundant throughout the entire Cayuga Lake basin.

Jaws subequal; anal rays 18 to 22; base of the anal fin 4 to 5 in the length of the body; individual variations many.

8. AMIURUS VULGARIS * Thompson.

(Long-jawed Cat.)

This species seems to be quite scarce; I found but one specimen among over one hundred of the former species. It was taken near Ithaca.

Lower jaw decidedly longer than the upper. Upper lip thin; anal rays 19; caudal fin slightly emarginate. Physiognomy considerably different from other species of the genus.

9. AMIURUS NATALIS * Le Sueur.

A., 331. B., 105. C., 15.

I have seen but one specimen of this species from the Lake. It was taken a few years ago.

Upper jaw usually the longer. Anal rays 26; base of the anal $3\frac{3}{4}$ in the length of the body; caudal fin rounded.

10. LEPTOPS OLIVARIS * Rafinesque.

(Mud-Cat.)

C., 14. *Pilodictis olivaris.* B., 101. A., 334.

The following is from a note kept by Dr. Wilder: "A large cat-fish was taken on a set line two miles below Sheldrake, about 1855, by Alex. Merian."

Mr. H. V. Kipp informs me that cat-fish are caught in the northern end of the Lake, reaching a weight of 25 pounds.

It is probable that these statements refer to this species, but possibly to *A. nigricans.*

Family VI. CATOSTOMIDÆ.

11. CATOSTOMUS CATOSTOMUS * Forster.

(Long-nosed Sucker.)

C., 17. *C. longirostris.* A., 320. B., 126.

My search for this species was in vain. It is found in the Adirondack region, and no doubt is a member of the Cayuga Lake fauna.

12. CATOSTOMUS TERES * Mitchill,

(Common White Sucker.)

A., 320. C., 18.

Catostomus commersoni. B., 129.

Very abundant through the entire Lake basin.

13. ERIMYZON SUCETTA * Lacépède.

(Chub Sucker.)

A., 319. B., 133.

Erimyzon sucetta oblongus. C., 19.

Very common about Cayuga and Montezuma. I know of none taken near Ithaca.

14. MOXOSTOMA MACROLEPIDOTUM * Le Sueur.

(Common Red Horse.)

A., 313. B., 140. C., 19.

I have seen but one specimen of this species from the Lake. Rather common at the northern end, so Mr. Kipp informs me.

Family VII. CYPRINIDÆ.

15. PIMEPHALES PROMELAS† Rafinesque.

(Black-headed Minnow.)

A., 288. B., 158. C., 22.

Length of largest specimen, about 6½ cm.

Head, 4 in the length of the body; depth 3¾ to 4.

Dorsal rays, 1–8; anal rays, 7; scales in the lateral line, 42–44.

Body elongate, robust; dorsal region rather prominent, more so than in *P. notatus*.

Snout bluntish, the mouth small and terminal, its gape forming a slight angle with the axis of the body. Margin of upper lip on a level with the ventral surface of the pupil; maxillary reaching about ¾ distance to vertical from the cephalic margin of the orbit. Premaxillaries protractile. Lateral line incomplete, pores on about 15 scales. Scales between the dorsal fin and the nape small and crowded.

Peritoneum black; alimentary canal about 2½ times the length of the body.

Teeth, 4–4, not hooked, all with the grinding surface developed.

Color olivaceous, somewhat silvery, darker on the sides.

The dark bar across the dorsal fin not very distinct; a faint dark spot at the base of the caudal.

The above description is based upon ten specimens taken from Fall Creek, between Triphammer Falls and Forest Home. I found this species only in this one locality.

This species is easily distinguished from others of the Cayuga cyprinoids by the very long intestine. Apparently not common.

16. PIMEPHALES NOTATUS† Rafinesque.

(Blunt-nosed Minnow.)

A., 288. B., 159. C., 22.

Length of largest specimens, about 7 cm.

Head, 4½ in the length of the body; depth 4 to 5.

Scales in the lateral line, 42–44.

Body elongate, dorsal region not prominent.

Snout very blunt, mouth small, the gape parallel with the axis of the body; the lower jaw the shorter, slightly overhung by the very blunt snout.

Margin of the upper lip on a level with the ventral surface of the orbit; end of the maxillary reaching ¾ distance to vertical from the cephalic margin of the orbit.

Lateral line complete, its cephalic half slightly decurved. Scales between nape and dorsal fin much crowded, being, as in *P. promelas*, much smaller in this region than on other parts of the body, 25 to 27 in a series.

Eye rather large, much larger than in *P. promelas.*

Teeth, 4–4, first slightly hooked, and the grinding surface developed on the first three.

Last ray of dorsal fin $\frac{2}{3}$ the length of the first ray. First dorsal ray slightly nearer the base of the caudal than the tip of the snout.

Peritoneum dark; alimentary canal about $1\frac{3}{8}$ times the length of the body.

Color olivaceous, more silvery than in the last species. The young have a dark lateral band, and a dark spot at the base of the caudal fin.

This species is found in large numbers in the southern end of the lake, and in streams on the flats. Not very abundant at the northern end of the lake and in streams near Ithaca, above the falls.

17. EXOGLOSSUM MAXILLINGUA † Le Sueur.

(Cut-lips: Stone-toter.)

A., 308. B., 160. C., 22.

Found by me, in small numbers, in Six-Mile-Creek and Fall Creek below the falls. It inhabits clear running water.

In this species, the dentary bones are united throughout their length; and on either side is a fleshy lobe, giving the lower jaw the appearance of a hare-lip when viewed from the ventral side. This character at once distinguishes this species from all others of the family.

18. NOTROPIS ANOGENUS † Forbes.

Length of largest specimens, about $4\frac{1}{2}$ cm.

Head 4 to $4\frac{1}{2}$ in the length of the body; depth $3\frac{3}{4}$ to 4. Dorsal rays 8; anal rays 8. Scales in the lateral line, 33 to 35.

Body rather elongate, dorsal region prominent. Snout pointed; mouth very small, its gape making an angle of 45° or 50° with the axis of the body. Maxillary reaching about $\frac{2}{3}$ distance to vertical from cephalic margin of the orbit, its length $4\frac{1}{2}$ to 5 in the length of the head. Margin of the upper lip on a level with the centre of the pupil. Eye large, its diameter 3 in the length of the head.

Pectoral fins small, their tips reaching $\frac{2}{3}$ distance to ventrals; tips of ventrals reaching the vent. Lateral line nearly complete. Teeth 4–4, all hooked and with the grinding surface slightly developed. Scales between nape and dorsal fin not crowded, about 14 in a series.

Color olivaceous, lighter below. A black band on sides passing around snout, about $\frac{2}{3}$ as wide as eye, the black on the snout on both jaws.

Quite common in the canal near Montezuma. It is the smallest of all the Cayuga fishes.

This species differs from *Notropis heterodon,* which it most resembles, in the small and very oblique mouth, and in the dentition.

19. NOTROPIS HETERODON † Cope.

Hemitremia heterodon. A., 303. B., 163. C., 22.

Length of longest specimens, about 5 cm.

Head 4 in the length of the body ; depth $4\frac{1}{4}$ to $4\frac{1}{2}$. Dorsal rays 8 ; anal rays 8. Scales in the lateral line, 34 to 36.

Body elongate, with the dorsal region prominent. Snout pointed ; mouth rather large, terminal; the jaws subequal in length ; gape of mouth forming a small angle (less than 35°) with the axis of the body.

Maxillary reaching to vertical from the cephalic margin of the orbit ; its length 4 in the length of the head.

First dorsal ray slightly nearer the tip of the snout than the base of the caudal fin. Pectoral fins reaching $\frac{3}{4}$ distance to ventrals ; ventrals reaching the vent.

Scales between the nape and the dorsal fin not crowded, 12 to 13 in a series.

Teeth 1–4–4–1; grinding surface little developed, usually crenate on the edges.

Straw-colored, with darker punctulations on the edges of the scales on upper part of the body ; nearly plain below. A dark plumbeous marking on the sides and around the snout, about $\frac{2}{3}$ as broad as the diameter of the eye. The black on snout on both jaws.

Quite common in all the sluggish water on the flats near Ithaca. Not found at the north end of the Lake ; it seems to be replaced there by the former species, from which it is quite different.

All the specimens examined by me had teeth 1–4–4–1. Prof. Gilbert has studied specimens of this species from New York, Indiana, Illinois and Missouri. He finds the teeth 1–4–4–1 or 2–4–4–2, and is of the opinion that examples will be found in which the teeth are 1–4–4–2.

20. NOTROPIS CAYUGA † sp. nov.

Length of the longest specimens, 6 cm.

Head $4\frac{1}{4}$ to $4\frac{1}{3}$ in the length of the body ; depth 4 to $4\frac{1}{2}$. Dorsal rays 8; anal 7.

Scales in the lateral line, 34 to 36.

Body elongate, rather deep, the dorsal region very prominent. In general form and appearance, this species closely resembles *N. heterodon.*

Snout short, less in length than the diameter of the eye, about $4\frac{1}{2}$ in the length of the head; mouth very small, its gape nearly parallel with the axis of the body; lower jaw the shorter, slightly overhung by the very blunt snout. Maxillary reaching about $\frac{1}{3}$ distance from vertical, from cephalic margin of the orbit. Eye 3 to $3\frac{1}{3}$ in the length of the head. Scales between the nape and the dorsal fin not crowded, 12 to 13 in a series.

First ray of dorsal fin nearer the tip of the snout than the base of the caudal fin, by a distance nearly equal to the length of the snout.

Length of the dorsal fin nearly the length of the head. Tip of first ray of dorsal reaching beyond the tip of last ray when the fin is deflexed.

Tips of pectoral fins reaching $\frac{3}{4}$ to $\frac{4}{5}$ distance to ventrals. Tips of ventrals reaching vent. Anal fin similar to dorsal fin, smaller.

Lateral line developed on 10 to 15 scales. Teeth 4—4, slightly hooked at their tips and with narrow grinding surface.

Color as in *N. heterodon*, the dark band on the snout on upper jaw only.

The specimens from the canal near Montezuma are darker than those from near Ithaca; this is probably due to the greater abundance of vegetation in the waters of the former situation.

There appears to be considerable individual variation in this species. The above description is taken from a number of specimens, which seem to represent the more constant and typical forms. Several specimens were taken near Ithaca, in which the first dorsal ray was situated midway between the tip of the snout and the base of the caudal fin, the scales between the nape and the dorsal fin being about 16 in a series. The body was more slender and the dorsal region less prominent than in those upon which the description is based.

These few latter specimens were of a larger size. I submitted examples of each to Prof. Gilbert, who compared them with specimens of the same genus from Indiana, Illinois and Missouri. He finds that the apparent differences between the Ithaca specimens are of no specific value. The lateral line is seldom if ever complete on any of the Ithaca specimens of either this or the two preceding species.

Prof. Gilbert is of the opinion that this species may be identical with *Minnilus microstomus* Raf. or with *Alburnus lineolatus*

Agassiz, or with both. As neither of these names is available, I have proposed a new name for it.

21. NOTROPIS WHIPPLEI† Girard.

(Silver-fin.)

B., 178. C., 25.

Hudsonius analostanus. A., 292,

Cliola analostana. B., 179.

Teeth 1—4—4—1, edges crenate, no distinct grinding surface.

Body compressed, scales on sides of the body deeper than long, appearing diamond-shaped.

Mouth terminal and oblique, snout pointed.

Eye small, 4 to 5 in the length of the head.

Lateral line complete. A large dark spot on last dorsal rays near their tips.

First dorsal ray midway between the nostril and base of the caudal fin.

Common on flats near Fall Creek, and in the southern end of the Lake. Not taken by me in other localities.

22. NOTROPIS MEGALOPS† Rafinesque.

(Shiner.)

C., 26.

Luxilus cornutus. A., 293.

Cliola cornuta. B., 186.

Teeth 2-4-4-2. Scales between the nape and the dorsal fin small and crowded, 22 to 30 in a series. First dorsal ray much nearer the tip of the snout than base of caudal fin. Scales on the sides of the body much deeper than long. Lateral line complete.

This species is very common throughout the entire lake basin.

23. NOTROPIS MEGALOPS FRONTALIS† Agassiz.

A., 293. B., 187. C., 26.

This variety differs from the typical form in having larger scales between the nape and the dorsal fin, 15 to 19 in a series.

Scarce near Ithaca. Common near Montezuma.

24. NOTROPIS LYTHRURUS† Jordan.

(Red-fin.)

Minnilus diplœmius. B., 197.

Teeth 2-4-4-2. Scales between dorsal fin very small, about thirty in a series. Body slender, similar in form to *N. atherinoides.*

One specimen taken from a small stream near Montezuma Dry Dock.

25. NOTROPIS ATHERINOIDES† Rafinesque.

(Rosy Minnow.)

C., 27.

Minnilus rubellus. A., 296. B., 202.

Head 4⅔ in the length of the body ; depth 5¼. Dorsal rays 8 ; anal 9. The last ray of the anal fin is produced into a short filament which is about ⅙ its entire length. First dorsal ray midway between the pupil and the base of the caudal fin. Base of anal 2 in the length of the head. Teeth 2-4-4-? (Teeth somewhat abnormally developed.)

I found but one specimen of this species near Ithaca. It was caught in Six Mile Creek, below the falls. A few specimens were also found with the preceding species. The above notes are from the former specimen only.

26. RHINICHTHYS CATARACTÆ† Cuvier and Valenciennes.

(Long-nosed Dace.)

A., 307. B., 207. C., 27.

I have seen no specimens of this species from the Lake basin. I insert it as possibly being a member of the Cayuga Lake fauna. It is quite common in the streams south of Ithaca, near Vanettenville, N. Y.

27. RHINICHTHYS ATRONASUS† Mitchill.

(Black-nosed Dace.)

A., 307. B., 208. C., 28.

Head about ¼ the length of the body. Mouth sub-inferior, less so than in the preceding species. Scales in the lateral line 60 to 68. Dorsal rays 8 ; anal rays 7. The young have a very distinct lateral band.

Common near Ithaca in all streams above and below the falls. None were taken near Montezuma.

28. HYBOPSIS KENTUCKIENSIS† Rafinesque.

(Horny-head ; River Chub.)

Cliola biguttata. B., 212.

Head 4 in the length of the body; depth 4.
Scales in the lateral line 41. Eye 4 in the length of the head. Barbel at end of maxillary well developed. Dorsal rays 7; anal 7.

A few specimens taken from Montezuma only.

29 SEMOTILUS ATROMACULATUS† Mitchill.

(Common Chub; Horned Dace.)

C., 29.

Semotilus corporalis. A., 304. B., 221.

Teeth 2—4—5—2; two or three hooked, without grinding surface. Snout pointed; mouth terminal and very large. End of maxillary reaching vertical from pupil.

Eye 4½ to 5½ in head. A dark spot at the root of first rays of the dorsal.

Very abundant throughout the entire Lake basin.

30. NOTEMIGONUS CHRYSOLEUCUS† Mitchill.

(Golden Shiner.)

A., 301. B., 250. C., 23.

Body very much compressed. Teeth 5—5.

Dorsal rays 8 or 9; anal rays 12 or 13. Scales in the lateral line, 44 to 46. Lateral line decurrent with the ventral outline.

Ventral surface between ventral fins and the vent forming a sort of keel, over which the scales do not pass

Found in sluggish water on the flats near Ithaca; none were taken near Cayuga or Montezuma, but it no doubt occurs there.

Family VIII. CLUPEIDÆ.

31. CLUPEA PSEUDOHARENGUS* Wilson.

(Alewife; Branch-herring; Saw-belly.)

B., 267. C., 36.

Pomolobus pseudoharengus lacustris. A., 279.

This species, although not a native of Cayuga Lake, is often found in large numbers in its waters. The fishermen about Ithaca know it by the name Saw-belly.

It is thought to have been introduced into the lakes of Central New York by the State Fish Commission.

Large numbers are often found dead upon the shores of Cayuga and Seneca Lakes.

All specimens seen by me were small.

For a full discussion of this species, see "Natural History of Aquatic Animals," by G. Brown Goode, page 588.

Family IX. SALMONIDÆ.

32. COREGONUS CLUPEIFORMIS* Mitchill.

(Lake White-Fish.)

A., 275. B., 299. C., 43.

I have seen no specimens of this species from the Lake, of which it is, however, undoubtedly an inhabitant.

33. COREGONUS ARTEDI* LeSueur.

(Lake Herring; Cisco.)

A., 274. B., 301. C., 43.

I have seen a few specimens of this species from the Lake, which had been taken some few years ago.

I here record but two species of Coregoni from the Lake. Others, no doubt, are inhabitants.

34. SALVELINUS NAMAYCUSH* Walbaum.

(Lake Trout.)

A., 272. B., 317. C., 44.

Hon. H. W. Sage informs me that this species used to be quite common in the Lake near Ithaca. About 1830 a large specimen was found stranded in Cayuga Lake Inlet, about 1½ miles from the Lake.

35. SALVELINUS FONTINALIS* Mitchill.

(Brook Trout.)

A., 272. B., 320. C., 44.

Found in small streams on the uplands throughout the Lake basin.

Family X. PERCOPSIDÆ.

36. PERCOPSIS GUTTATUS† Agassiz.

(Trout Perch.)

A., 270. B., 322. C., 44.

I have seen no specimens of this species from the Lake, of which it no doubt is an inhabitant.

Family XI. CYPRINODONTIDÆ.

37. FUNDULUS DIAPHANUS† LeSueur.

(Barred Killifish.)

A., 263. B., 334. C., 49.

Lateral line 45 to 50. Dorsal rays 12 to 13; anal 11 or 12.

Common on the flats and in the southern end of the Lake; streams on the uplands; Cayuga and Montezuma.

Family XII. UMBRIDÆ.

38. UMBRA LIMI Kirtland.

(Mud Minnow.)

A., 265. B., 350. C., 51.

Not found by me near Ithaca. Taken in small numbers near Cayuga and Montezuma.

Family XIV. ESOCIDÆ.

39. ESOX RETICULATUS* LeSueur.

(Eastern Pickerel. Green Pike.)

A., 267. B., 353. C., 50.

Lateral line 116 to 120. Branchiostegals 13 to 15. Dorsal rays 13 or 14; anal rays 12 or 13. The largest specimen seen by me from the lake was 55 cm. in length.

This species seems to be subject to individual variations. In many respects the specimens seen from the Lake seem to be intermediate between this species and the *E. vermiculatus*.

Not very common.

40. ESOX LUCIUS* Linnæus.

(Great Lake Pike; Pike.)

A., 266. B., 353. C., 51.

Lateral line 110. Branchiostegals 15. Dorsal rays 18; anal rays 15.

Not common, found only in the Lake and streams below falls.

This species reaches a much larger size than the preceding. It is probably confounded by fishermen with the Muskallonge (*E. masquinongy=nobilior*).

Seth Green informs me that the Muskallonge has been taken from Cayuga Lake. Several fishermen also maintain the same. Yet in no case were they able to recognize more than two species, *E. reticulatus* and *E. lucius*. Mr. Kipp does not regard the Muskallonge as an inhabitant of Cayuga Lake. I am inclined to believe that he is correct, and so omit it from this list.

E. lucius is light-spotted, while *E. masquinongy* is dark-spotted; and so the two are easily distinguished.

Family XV. ANGUILLIDÆ.

41. ANGUILLA ANGUILLA ROSTRATA* LeSueur.

(Common American Eel.)

A., 338. B., 361. C., 55.

Not common, occasionally taken from each end of Cayuga Lake.

Family XVI. GASTEROSTIDÆ.

42. EUCALIA INCONSTANS CAYUGA† Jordan.

(Brook Stickleback.)

A., 259. C., 68.

Gasterosteus inconstans. B., 394.

Free dorsal spines, 4 to 6.

Common in standing and sluggish water on the flats; none were taken by Mr. Harris or myself at the northern end of the Lake.

Family XVII. ATHERINIDÆ.

43. LABIDESTHES SICCULUS† Cope.

(Silver Skip-Jack.)

A., 261. B., 406. C., 65.

Not found near Ithaca. Several specimens were taken from a small stream which empties into the Canal a few rods south of Montezuma. This locality is the most Eastern known for this species.

Family XVIII. CENTRARCHIDÆ.

44. POMOXIS SPAROIDES* Lacépède.

(Grass Bass; Calico Bass.)

B., 464. C., 76.

Pomoxys nigromaculatus. A., 247.

One specimen, 17 cm. in length, was taken with the former species. Fishermen say that it is frequently taken from the Canal.

Pomoxis annularis Raf. may also be found in the Canal.

45. AMBLOPLITES RUPESTRIS* Rafinesque.

(Rock-Bass.)

A., 237. B., 466. C., 76.

A very common and well-known species.

46. LEPOMIS CYANELLUS* Rafinesque.

(Blue-Spotted Sun-fish.)

B., 473. C., 77.

Apomotis cyanellus. A., 239.

Not found by me near Ithaca. A few specimens were taken near Montezuma.

47. LEPOMIS PALLIDUS* Mitchill.

Found in small numbers with the preceding.

48. LEPOMIS GIBBOSUS* Linnaeus.

(Pumpkin-Seed.)

B., 482, C., 77.

Eupomotis aureus. A., 244.

Very common throughout the entire Lake basin.

49. MICROPTERUS SALMOIDES* Lacepede.

(Large-mouthed Black Bass; Oswego Bass.)

B., 484. C., 77.

Micropterus pallidus. A., 236.

Rather scarce near Ithaca. More common near Montezuma and Cayuga.

50. MICROPTERUS DOLOMIEU* Lacepede.

(Small-mouthed Black Bass.)

B., 485. C., 77.

Micropterus salmoides. A., 236.

Not found by me near Ithaca; less common than the preceding near Cayuga and Montezuma.

Family XIX. PERCIDÆ.

51. ETHEOSTOMA NIGRUM OLMSTEDI† Storer.

(Tessellated Darter.)

A., 224. B., 492. C., 78.

Common at each end of the Lake, but not found in the streams at the Southern end above the Falls.

52. ETHEOSTOMA FLABELLARE† Rafinesque.

(Fan-tailed Darter.)

A., 227. B., 513. C., 80.

Found with the preceding. These two are the only species of darters found. It seems very strange to me that even these were not found in the streams on the uplands.

Darters frequent shallow running water, especially if it is clear and the bottom of the stream is rocky.

Such are the characters of the upland streams near Ithaca.

Both Six Mile Creek and Fall Creek flow from the uplands to the lake in a series of cascades. It is impossible for fishes to ascend these falls, even in the case of high water. This fact gives considerable interest to the study of the fishes of these two streams; and the same is true of Cascadilla and Buttermilk creeks.

PERCA FLAVESCENS* Mitchill.

(Common Yellow Perch.)

C., 81. *Perca americana.* B., 524. A., 229.

Common throughout the Lake basin.

53. STIZOSTEDION VITREUM* Mitchill.

(Wall-eyed Pike.)

A., 230. B., 325. C., 81.

Found in the Lake, but not common.

54. STIZOSTEDION CANADENSE* Smith.

(Sand-Pike.)

A., 230. B.. 526. C., 81.

Found with the preceding species; less common.

Family XX. COTTIDÆ.

55. COTTUS ICTALOPS† Rafinesque.

(Miller's-thumb; Star-Gazer.)

B., 696. C., 111. *Potamocottus richardsoni.* A., 254.

Palatine teeth developed. Ventral rays 1–4, dorsal fins connected. Body very robust. Paired fins broad.

Southern end of Cayuga Lake.

56. COTTUS ICTALOPS BAIRDI† Girard.

A., 254. B., 697. C., 111.

This variety differs from the former in having a less robust body; the dorsal fins scarcely if at all connected; and the paired fins and palatine teeth less developed.

The two forms apparently grade into each other.

Found with the preceding.

57. COTTUS GRACILIS† Heckel.

A., 252. B., 699. C., 111.

Palatine teeth usually absent. Ventral rays 1—3. Head $3\frac{1}{3}$ to $3\frac{2}{3}$ in length of the body; depth $4\frac{1}{3}$ to $5\frac{1}{2}$. Dorsal rays vii., viii. Anal 11-13.

I have examined specimens of this species from the southern end of Cayuga Lake, Beaver Creek, McLean, N. Y., Worcester, N. Y., and Bangor, N. Y. All apparently belong to the same species.

Less common than the former species.

58. COTTUS GRACILIS CAYUGA† Var. Nov.

One female specimen 10 cm. in length.

Head $3\frac{2}{3}$ in the length of the body; depth $6\frac{1}{2}$. Dorsal rays vii.-17. Anal rays 12.

Body very slender. Preopercular spines large and strongly hooked, not covered by the skin. Paired fins comparatively small, otherwise not essentially different from *C. gracilis*.

This specimen was taken from Cayuga Lake a few years ago. It appears quite different from the preceding.

It is not unlikely that these, as well as other described forms, will prove to be but varieties of *C. ictalops*.

Family XX. GADIDÆ.

59. LOTA MACULOSA Le Sueur.

(Aleky Trout; Burbot.)

A., 257. B., 802. C., 129.

Found in the Lake; very scarce.

In the foregoing list, we have represented 20 families and 59 species, including varieties. Of these species, 26 are commonly used as food for man. 28, together with the young of all species, are used as food by all the carnivorous fishes, while the remaining 5 are of little or no economic value.

COE COLLEGE, CEDAR RAPIDS, IOWA, March 20, 1888.

XIV.—Description of a New Spermophile from California.

Spermophilus beldingi, sp. nov.

BY C. HART MERRIAM.

Read December 17th, 1888.

During the summer of 1885, Mr. L. Belding sent me a Spermophile from the summit of the Sierra Nevada Mountains, in Placer Co., California, which was unlike any I had previously seen. It belonged to the genus *Spermophilus*, and evidently was more closely related to *S. richardsoni townsendi* than to any other species, though it differed materially from the published descriptions of that animal. Its most striking characteristic was a broad dorsal band of rufous, which was separated from the yellowish of the sides by a distinct line of demarcation. Moreover, it lacked the indistinct spots which are characteristic of *townsendi*. Believing this interesting Spermophile to be undescribed, and desiring to secure a number of specimens, I engaged Mr. Charles A. Allen, of Nicasio, to visit the locality where Mr. Belding discovered the species. Mr. Allen had no difficulty in finding its haunts, and succeeded in capturing a fine series of specimens, which served to emphasize its distinctness. Unwilling, however, to describe it without actual comparison with *S. townsendi*, I have been forced to wait until the present autumn for the opportunity, which I now possess, and which shows the new species to differ even more markedly from *townsendi* than I had supposed. I take pleasure in naming it in honor of its discoverer, Mr. L. Belding, of Stockton, California, whose contributions to the knowledge of the zoology of the region, particularly its ornithology, entitle him to lasting remembrance. The new species may be recognized from the following description:

SPERMOPHILUS BELDINGI, sp. nov.

Sierra Nevada Spermophile.

Type, $\frac{2718}{3342}$, ♀ ad., Merriam Collection. From Donner, California, June 22d, 1886.

DESCRIPTION OF TYPE.—Size about equal to, or a trifle larger

than, *S. townsendi;* total length (measured in the flesh), 292 mm.; tail, 89 mm.; hind foot (measured from the dry skin after moistening sufficiently to straighten the toes), 45 mm.; height of ears above crown (in dry skin), 6 mm. Claws long and powerful, nearly straight. Hind foot with posterior third of sole well haired. Tail sub-cylindrical, not bushy. Ear large for a member of the *S. richardsoni* group; well clothed with hair on both sides; auricle strongly convex anteriorly, slightly emarginate posteriorly; antero-posterior diameter considerably exceeding the vertical. Pelage rather coarse.

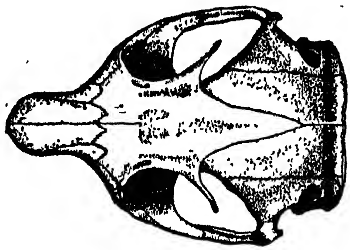
Color.—The most conspicuous color character is a broad dorsal band of bright rufous, which extends from the nape to the root of the tail, and is sharply separated from the dull, grizzled yellowish-gray of the sides and under parts. This rufous band, in passing over the rump, tapers rapidly to the root of the tail, where it becomes continuous with the broad median stripe of the upper surface of the tail, which is bordered with yellowish. The tail is bright chestnut underneath, and has a subterminal black band which is more sharply defined below than above. The top of the head, from nose to occiput, is rufous like the dorsal band, from which it is indistinctly separated along the nape. There is a white streak on each eyelid. The back and sides show a slight admixture of black-tipped hairs, producing a faint suggestion of vermiculation. These black hairs are most numerous on the upper surface of the tail, particularly along its sides, between the yellowish border and the rufous median stripe, where on each side they form an indistinct narrow black band, which is continuous with the broad, subterminal band of the same color. The cheeks and ears are dark-grayish, slightly grizzled. The chin and throat are whitish. The upper surfaces of both fore and hind feet are light yellowish-gray.

Remarks on other Specimens.—My series of *S. beldingi* consists of 20 skins and 26 skulls from the neighborhood of Donner, Placer Co., California, and one young from Bear Valley, Mariposa Co. Many of the specimens are nursing females; the normal number of teats is $\frac{5}{5}$. Measured in the flesh, the total length varies from 275 to 300 mm., and the tail from 76 to 89 mm. In the adult there is very little color variation. Sometimes the rufous of the head is continuous over the nape with

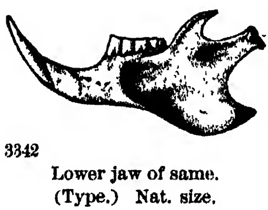
the dorsal stripe. In one specimen (No. 4,720 ♀) the vermiculations on the rump are much more distinct than in the others. Sometimes there is a blackish stripe above the white stripe of the upper eyelid. Sometimes there is a touch of rufous on the outside of the ankle. In one specimen (No. 2,708 ♀) the tail is considerably broader sub-terminally than toward the base. A single individual (No. 4,721 ♂) has the rufous dorsal band duller and paler than in the others, though still sharply defined. The posterior third of the sole is well covered with hair, except in No. 4,719 ♀, in which it is entirely naked—probably the result of unusual wear (the tail in the same specimen is very shabby). Sometimes the dark basal portion of the fur on the belly shows through.

Cranial characters.—On comparing a series of skulls of *Spermophilus beldingi* from Donner, California, with a corresponding series of its nearest ally, *S. richardsoni townsendi*, from near Laramie, Wyoming, several excellent specific characters may be seen. The most noticeable of these, viewing the skull from above, is the great breadth of the interorbital plane of the frontals, which projects well out over the orbits, and in adult skulls is perforated by the supraorbital foramina. In young skulls this foramen is incomplete externally, existing as a deep notch. The average ratio of interorbital breadth to basilar length in nine skulls of *beldingi* is 28.0; in two skulls of *townsendi* it is 22.9. The premolar is very much larger in *townsendi* than in *beldingi*, though it is by no means small in the latter. It is the large size of this tooth in *townsendi* that gives the molar series the relatively greater length shown in the table of measurements of that species. In adult skulls of *beldingi* the post-palatine foramina are situated wholly within the palatine bones; in *townsendi* they are on the palato-maxillary suture. In *beldingi*, compared with *townsendi*, more of the base of the presphenoid bone is exposed behind the shelf of the palatine; the foramen behind the last molar is conspicuously larger; the foramen magnum is notably smaller, and its vertical diameter is relatively as well as actually much shorter. This last peculiarity is correlated with an actual difference in the posterior plane of the skull, which is larger and more highly arched in *townsendi* than in *beldingi*. Even the under-jaw presents a strik-

ing character, and one by which the two species may be separated at a glance. In *beldingi* the coronoid process is shorter, smaller, more slender, and bent more abruptly backward than in *townsendi*. There is also a difference in the height of the condylar process above the angle.



3342
Spermophilus beldingi Merriam, ♀ ad.
(Type.) Nat. size, skull.



3342
Lower jaw of same.
(Type.) Nat. size.

CRANIAL MEASUREMENTS OF SPERMOPHILUS BELDINGI AND S. RICHARDSONI TOWNSENDI.

	Spermophilus beldingi, sp. nov.									S. townsendi.	
	1818	3333 ♀	3338 ♀	3340 ×	3341 ♂	3342 ♀	3343 ♀	3364 ♂	5371 ♀	5285 ♂	5284 ♂
Basilar length (from one of the occipital condyles to posterior edge of alveola of incisor of same side)	38.4	39.	39.2	38.3	40.	41.	39.	41.7	38.2	38.8	38.7
Basilar length of Hensel (from inferior lip of foramen magnum to posterior edge of alveola of incisor)	36.	36.6	36.6	36.	37.5	38.5	36.6	38.8	35.8	36.3	36.
Greatest zygomatic breadth	28.7	29.3	28.5	28.	28.90	29.	28.	29.	27.6	29.6	29.2
Greatest mastoid breadth	20.	20.7	20.3	19.6	20.	20.6	20.8	21.3	19.7	21.1	20.6
Interorbital constriction	11.	10.5	11.4	11.	11 4	11.2	11.4	11.3	10.2	9.	8.8
Greatest length of nasal bones	16.	15.3	15.9	16.	15.7	16	16.5	16.	15.4	16.	15.8
Incisor to post-palatal notch	21.3	20.8	21.6	21.4	22.	22.	21.5	22.4	21.	21.6	20.7
Incisor to first molar	10.5	10.7	10.5	10.7	11.4	11.3	11.	11.5	10.4	9.7	9.8
Length of upper molar series (measured on alveolæ)	9.4	9.3	9.3	9.5	8.8	9.5	9.	9.5	9.3	10.	10.2
Distance between alveolæ of upper molar series anteriorly	6.6	7.8	7.8	..	7.5	8	7.8	7.4	6.4	7.5	7.
Distance between alveolæ of upper molar series posteriorly	6.3	6.6	6 7	6.3	6.4	6.8	6.8	6.8	6.	7.	6.
Foramen magnum to post-palatal notch	15.2	16.2	15.5	15.	16.	16.9	15.5	15.8	15.2	14.8	15.5
Length of mandible	28.5	29.5	29.	29.1	29.6	30.	29.7	30.2	28.7	29.	28.6
Height of mandible from angle to coronoid	14.5	15.4	14.6	14.6	15.7	15 3		15.2	15.	16.	15.9
Length of under molariform series (measured on alveolæ)	8.4	8.5	8.	8.5	8.3	8.7	8.3	8.7	8.2	9.	8.8
Ratio of interorbital breadth to basilar length	28 6	26.9	29.1	28.7	28.5	27.3	29.2	27.1	26.7	23.2	22.7

XV.—A Preliminary Monograph of the North American Species of Trogophlœus.

BY THOS. L. CASEY.

Read December 17th, 1888.

In describing the components of a large genus of minute, closely-allied insects, the question often recurs, whether or not the labor is being usefully expended, and whether the descriptions alone will enable future investigators to recognize the species. The thought doubtless comes to some of us, that perhaps after all it would be just as well to let all but the better-marked species go unrecorded; but as long as the fascinating nature of the subject gives rise to enthusiasm in the study of microscopic articulates, we must expect descriptive work, and when monographic, this should be made as complete as possible in order to avoid ambiguity. To attain the desired object, however, the question of subsequent identification becomes one of vital importance.

In order that any particular species may be recognized without reasonable doubt, one of three courses must inevitably be taken:

1. To so preserve the type specimen that it shall be indestructible.

2. To reproduce the type on paper by means of a drawing, which shall be practically faultless, and large enough to display all the characteristic details of sculpture and vestiture.

3. To draw up a description in language so full, explicit, and detailed that there can be no doubt of its effectiveness, provided the conditions under which the specimen is examined, are the same in general principle as those under which the original was produced.

In regard to the first condition, there can be no disagreement as to the difficulty of preserving specimens with exposed mounting from those engines of destruction—insect pests, mould and human manipulation, and even when mounted in an in-

closed space, as recommended by Dr. Sharp and M. Raffray, there are causes at work, accidental or otherwise, which will in time cause their destruction; so that it is scarcely plausible to hope to keep them intact for a greater period than, say, several centuries.

To delineate a specimen with all the useful detail observable in nature, is, although not perhaps an impossibility, a result which has never yet to my knowledge been attained, and the enormous expense of such a course would probably forever prevent its applicability. With an objective of an inch and a half for instance, a specimen two millimetres in length appears to be eighty. This is the minimum useful working power for insects of this size, and under these conditions the characteristic nature of pubescence, punctuation, and tegumental structure first suggest themselves. Our figures would, therefore, necessarily have to be of these dimensions, in order to reproduce the useful differential elements with any degree of accuracy. It is true that mere outline, and a representation of the larger and more striking characters, will serve to identify a vast number of species; but there are many genera, especially in the Staphylinidæ, where it occasionally happens that greater detail is absolutely necessary in order that there may be any certainty of recognition.

Arriving at the third condition, there is one fact which it appears to the author should receive more consideration than is usually given it, viz.: that the description is absolutely indestructible; printed in unalterable carbon, it will endure for unlimited time, if not in its original shape, at least in the photolithographic reproductions which in coming years will render the complete restoration of a volume a matter of very little cost and labor. It seems, therefore, that an effort on the part of authors to arrive at the ideal of perfection in the typical description, would be the best course to take; a description which, while being concise, should be practically complete and thoroughly exhaustive. A concise and uniform system of nomenclature for all the parts and structures described, would be an effective foundation for such a descriptive system, since ordinary language is too verbose, and at the same time too indefinite for such purposes.

The production of such an ideal description would be much facilitated also by improvements in the mechanical accessories of the microscope. There is no reason, for instance, why the simple stage-forceps should not be supplemented by an additional arm, securely attached to the upright portion of the stand which carries the stage, and provided with a fine screw-motion for elevation and depression. This additional arm might easily be provided with a steel spring, holding a square piece of very thin glass, ruled by some one of the delicate dividing-engines, so well known at the present day, to twentieths of a millimetre, in a transverse and a vertical direction, forming squares of the indicated dimensions. The movable stage, carrying the forceps which support the mounted specimen, being moved in such a way as to bring the insect under the glass scale, the latter could be depressed, so as to approach very near to the upper surface of the object, and the transparency of the glass would readily admit of any desired measurements. Readings could, by estimation, be made to the tenth part of the least division of the scale, or in this case to the .005 part of a millimetre. In the various species of *Trogophlœus*, the mutual distance of the minute punctures, even when unusually dense, could easily be expressed in such a unit. In this way the diameter of the punctures, their average mutual distances in various portions of the body, the length of pubescence, length and width of scales, length of the antennæ, femora, tibiæ, and tarsi, diameters of the eye and of its minute component lenses, length and width of all the major parts of the body, and many other facts, could be recorded in absolute numerical quantities.

I am far from believing this to be a mere flight of fancy. In describing any animal of large size and higher organization, it would undeniably be considered invocative of criticism if actual measurements of the various parts of the arms and legs, of the hairs, ears, eyes, and other similar facts were not given; and yet in the animals treated of in the present paper, the variation in any part of the body is so much less from individual to individual of the same species, that if such facts could be recorded, they would be of much greater relative value.

Regarding the species of large and difficult genera, the ordinary description is confessedly inadequate. There is not one of

those given in the present paper which can properly be considered more than a mere rough diagnosis. If, for instance, instead of saying "prothorax one-half wider than long, narrower than the elytra, strongly rounded at the sides, narrowed toward base, densely punctate," which is one of the usual forms of orthodox diagnosis, and which might apply equally well to a great many species of the same genus, we could give the actual width at the widest part, the distance of this line from the apex measured along the median line, the length of the latter, and the width of base and apex, we should have something absolute to guide us. The terms coarsely, finely, densely, sparsely, etc., have no meaning except in a relative sense, and what, for instance, in one genus or part of a genus, may be dense punctuation, may in another be quite sparse. An absolute scale of measurement would therefore prove of inestimable value in this respect also.

Another advantage of the proposed system should not pass unnoticed, as it is of very great importance. On examining the greatly magnified image of an insect, it will be apparent after a little experience, that the mutual relationship of the larger parts of the body, especially in regard to relative dimensions, is not so easily grasped as in the very much reduced image of the hand-lens. This should not be urged against the use of the microscope, because it simply arises from the fact that the eye is unable to consider, at the same instant, two widely separated parts of the body in such a large image. If the system of actual measurements be employed, however, this fault would be entirely overcome, and the only objection which can reasonably be urged against the use of the microscope would be forever set at rest.[1]

[1] The objection urged by several entomologists, that the greatly enlarged images given by the microscope bring so much detail into view as to cause undue weight to be given certain characters which may be individual rather than specific, is scarcely worthy of consideration. That it is true of the novice who has not yet learned to interpret what he sees, none can speak with more feeling than the author himself, who, in his earlier inexperience, was led into several very regrettable errors, and notably in the case of *Harpalus viridiæneus*, wherein he overestimated the importance of the rôle played by certain adventitious setæ; but to say that, in a mature judgment, the mere fact that every

In general one set of measures would be sufficient, and in such variable species as *Bryonomus canescens* and *Coniontis Eschscholtzii*, the measurement of three specimens would, if placed in tabular form, give a satisfactory idea of the species with the consumption of very little additional space. In fact, the proposed method would rather tend to curtail the ideal description than to augment it, for much could be given absolutely, in numbers placed in tabular form, which is now expressed by comparisons in lengthy and cumbersome language.

While the world has progressed with astonishing rapidity in almost every other channel, we find ourselves making use of the same imperfect tools which were employed fifty years ago, more or less improved as to spherical and chromatic aberration, it is true, but after all the same inconvenient and inadequate hand-lenses. But little satisfactory progress in the science of entomology can be made, until this defect is remedied. We must see clearly and beyond peradventure of doubt those things the knowledge of which we would wish to promote by original investigation. Optical and mechanical skill have progressed sufficiently to give us the means, and we have but to adopt and utilize them.

New York, Dec. 5, 1888.

In a preliminary revision, such as that which follows, it is unnecessary to dilate upon generic characters, or to speculate upon the exact position of the genus with reference to its affinities, or even to name the subgeneric divisions, unless they be of unusual interest, which is not a feature of the present case. It should be said, however, that I have been unable to follow all the divisions proposed by our honored predecessor, Dr. Le Conte, since variation in the distance of the eye from the mandibles is very deceptive under inadequate magnifying powers, and does not actually exist in such a way as to be of decided taxonomic value. The maxillary palpi, although more slender and elongate in some than in others, present intermediate forms, so that the

detail of an insect is brought plainly into view, must necessarily and of itself give rise to mistakes regarding specific characters, is the veriest absurdity.

value of this element is also slight. The lateral elytral carina is present in all; it is entire, and generally somewhat remote from the edge.

Many of the species resemble small, slender Aleocharini, and especially the subgenus Hydrosmecta, but they can be distinguished at the first examination, not only by the position of the antennæ, but by the very coarsely faceted eyes, a striking character which they possess in common with Bledius and Thinobius. The number of species is probably enormous and in our own country can scarcely fall far short of two hundred.

The provisional grouping here presented has the faults of nearly all subdivisions of large genera, in that there are several intermediate forms; these, however, are very few in number, and the exceptions should give rise to but little doubt. The groups may be defined as follows:—

Pronotum with a transverse arcuate groove near the base.......... **I.**
Species 1-4

Pronotum unimpressed or with two approximate, longitudinal impressions in the middle of the disk and toward base, but without trace of transverse impression.

Prothorax with the apical angles acute, anteriorly prominent and dentiform; sides subangulate................................... **II.**
Species 5-12

Prothorax without prominent anterior angles, the sides generally more broadly rounded.

Eyes large, convex, and prominent, the tempora[1] short behind them, much less prominent and usually acute at the posterior extremity, the head being limited behind by a well-marked transverse constriction; sides of the prothorax sometimes very narrowly rounded, approaching the subangular; disk of pronotum always bi-impressed.. **III.**
Species 13-22

Eyes small, much less prominent, the tempora behind them quite as prominent, more or less strongly arcuate, generally nearly as long as and sometimes longer than the eye; pronotum generally bi-impressed.. **IV.**
Species 23-44

[1] The word *tempora* is used to designate the sides of the occiput, which I have sometimes, less accurately, referred to as the post-ocular portions of the genæ in previous descriptions. This portion of the head playsna important part in the internal classification of many Staphylinide genera, and notably in the South American representatives of Sciocharis.

Eyes large, convex, and prominent, the tempora totally obsolete, the sides of the head rapidly narrowing to the neck, the head not limited behind by a transverse constriction; pronotum generally unimpressed ....V.
Species 45-66

Group I.

The form of body prevailing in the few species of this group is rather robust and convex, with relatively wide elytra and abdomen, and narrow head and prothorax. The palpi in the more specialized forms are decidedly longer than in the other species, the third joint especially being more elongate, slender, and fusiform, with the truncate apex more minute. The antennæ are long and slender, and in at least one, the second joint is, contrary to the general rule, shorter than the third. The abdomen is coarsely and more distinctly punctate.

These various divergencies, taken in conjunction with the pronotal modification, appear at first glance to warrant the generic separation of the group; but on further observation it becomes apparent that this cannot be done with propriety. The palpi, for instance, in *arcifer* are of the normal form, and the antennæ shorter, with the basal joints normal, while the pronotal structure is as strongly marked as in *caloderinus*, which is perhaps the most specialized form of the group. Again, in *T. ingens*, subsequently described, which in general appearance is very different, the abdomen is coarsely punctate. There remains therefore only one character which constantly differentiates these species from the others—the transverse basal impression of the pronotum. The two longitudinal impressions of the majority of species form, however, a character of such persistence, and so characteristic of the genus, that any radical variation, such as is seen here, may be of greater systematic importance than is apparent in preliminary study.

The sexual characters in the present group are decidedly more marked and diversified than in the others, this being apparent in some at the abdominal vertex and in others in the antennæ, which, for instance, in the male of *anthracinus*, are very much longer and more slender than in the female.

The species may be separated as follows:—

Second antennal joint slightly shorter than the third..1 **caloderinus**
Second antennal joint longer than the third.
Dark ferruginous, legs pale ; antennæ without distinct sexual differences..2 **arcifer**
Black, legs and antennæ black ; sexual differences in the antennæ very marked.
Prothorax less transverse, widest before the middle.
3 **anthracinus**
Prothorax more distinctly transverse, widest at the middle.
4 **corvinus**

1. **T. caloderinus** Lec.—Trans. Am. Ent. Soc., VI., p. 246.

The original description will amply serve for the recognition of this very distinct species, but it may be well to state that the disk of the prothorax is polished, the punctures being excessively fine, sparse, and feeble, and almost completely obsolete, except between the arcuate basal impression and the base, and thence laterally and anteriorly near the sides in basal two-thirds, where they are coarse, deep, and conspicuous. The body is rather more robust and convex than in the other species of the group. The fourth joint of the maxillary palpi is very short and slender, but is not by any means obsolete, as supposed by Dr. Le Conte.

Several specimens collected by Mr. Schwarz at Columbus, Texas, are very immature, and seemed on a casual examination to indicate a distinct and much more depressed form, showing to how great an extent mere immaturity may alter the appearance of these species.

2. **T. arcifer** Lec.—Trans. Am. Ent. Soc., VI., p. 245.—Moderately robust and convex, dark rufous; head, and abdomen toward apex clouded slightly with piceous ; legs and antennæ pale fuscous, the latter flavate at base ; pubescence rather long, coarse and dense, nearly erect, rather conspicuous ; integuments shining. *Head* scarcely more than three-fourths as wide as the prothorax, feebly convex, coarsely, deeply and rather sparsely punctate ; interspaces convex and polished ; prominences moderate in size, distinct ; eyes large, convex, and rather prominent, the tempora behind them very short, strongly rounded and not at all prominent ; antennæ distinctly longer than the head and prothorax, slender, very feebly incrassate; second joint slightly but distinctly longer than the third, the latter obconical, twice as long as wide, fourth slightly longer than wide, with the sides nearly parallel, tenth one-third wider than long. *Prothorax* nearly one-half wider than long, widest a little before the middle, where the sides are strongly rounded and obtusely

subangulate, thence very distinctly convergent and feebly arcuate to the apex, slightly more strongly convergent and very feebly sinuate to the base, which is broadly, very feebly arcuate, three-fourths as wide as the disk and but slightly narrower than the apex, the latter truncate; apical angles very slightly anteriorly prominent and obtusely subdentiform; disk coarsely, deeply, but not very densely punctate throughout; punctures impressed; basal impression very strong. *Elytra* very distinctly shorter than wide, distinctly wider at apex than at base, two-fifths wider and one-half longer than the prothorax, impressed near the suture toward base, coarsely but not very densely punctate. *Abdomen* almost as wide as the elytra; sides strongly arcuate; border not very wide but rather deep; surface coarsely and moderately densely punctate, the punctures smaller and feebler than those of the other portions of the upper surface; interspaces polished and not at all reticulate. *Legs* moderate. Length 2.8 mm.

Texas (Austin 2).

May be distinguished by its pale colors, and strongly punctate surface. The sexual differences in the antennæ are not remarkable.

The type in the cabinet of Le Conte is from Florida, and is almost devoid of pubescence; the latter is very easily removable in the species of this group. The description is drawn from the Texan specimens.

3. **T. anthracinus** n. sp.—Rather robust, moderately convex, intense black throughout, palpi and tarsi slightly piceous; pubescence moderate in length, rather sparse; integuments polished. *Head* distinctly narrower than the prothorax, somewhat coarsely, deeply, moderately densely punctate; prominences well marked; eyes rather large, convex, somewhat prominent; the tempora very short, not prominent; nuchal constriction almost obsolete; antennæ distinctly longer than the head and prothorax, slender, club small; joints two to eight all much longer than wide, two to four decreasing slowly in length, ninth obtrapezoidal, slightly longer than wide, and distinctly longer than the tenth, which is a little wider than long, eleventh slightly longer than wide, abruptly and finely pointed. *Prothorax* widest at two-fifths its length from the apex, where the sides are very obtusely subangulate and narrowly rounded, thence feebly convergent and feebly arcuate to the apex, more strongly convergent and feebly sinuate to the base, which is but very slightly narrower than the apex, the latter truncate; apical angles not distinctly rounded; disk scarcely one-third wider than long, somewhat coarsely and moderately densely punctate throughout; basal impression strong; surface behind it arcuately tumid. *Elytra* distinctly wider than long, nearly one-half wider and two-thirds longer

than the prothorax, each broadly and distinctly impressed near the suture toward base; disk somewhat coarsely, but not very densely punctate. *Abdomen* slightly narrower than the elytra, much narrower at apex than at base; border rather narrow and deep; surface polished, not at all reticulate, each segment moderately coarsely, but not densely punctate at base and almost impunctate at apex. Length 2.8 mm.

Kentucky 2, Mr. Lugger; Virginia (Lee Co. 1), Mr. Schwarz.

The above description is taken from the male. In the female the antennæ are much shorter, equal in length to the head and prothorax, the outer joints shorter and more robust, two to four decreasing very rapidly in length, the ninth and tenth equal in length, and both distinctly transverse. The abdomen, also, is less distinctly narrowed at apex. For the genus Trogophlœus, these sexual differences are very marked.

4. **T. corvinus** n. sp.—Robust, moderately depressed, intense black throughout, tarsi very slightly piceous; pubescence rather coarse, long and rather conspicuous on the abdomen, elsewhere short; integuments polished. *Head* distinctly narrower than the prothorax, moderately convex, deeply, moderately coarsely, and rather densely punctate laterally, almost impunctate in the middle; prominences rather short, strong; eyes moderate, convex, and but slightly prominent: tempora broadly rounded and convergent to the neck, short, not at all prominent; antennæ slightly longer than the head and prothorax, moderately slender; joints two to eight longer than wide, two to four decreasing slowly in length, ninth as wide as long, slightly longer than the tenth which is one-third wider than long. *Prothorax* two-fifths wider than long, widest in the middle, where the sides are obtusely and distinctly subangulate, thence feebly convergent and feebly arcuate to the apex, more strongly convergent and distinctly sinuate to the base, which is four-fifths as wide as the disk, and but slightly narrower than the apex, the latter truncate; apical angles not appreciably rounded; disk deeply, moderately coarsely and densely punctate throughout; basal impression strong, nearly transverse and abruptly arcuate laterally, the surface immediately behind it strongly tumid. *Elytra* slightly wider than long, one-half longer and nearly one-half wider than the prothorax, broadly impressed near the suture toward base, deeply, coarsely and moderately densely punctate. *Abdomen* very slightly narrower than the elytra, slightly narrower at apex; segments sparsely punctate, the punctures coarser toward the base of each. Length 2.7 mm.

Massachusetts (Lowell 2). Mr. F. Blanchard.

This description is also taken from the male, the female pre-

senting antennal differences corresponding with those of the preceding species, but less marked. It resembles *anthracinus* very strongly, but may be distinguished by its more robust form, relatively larger and more transverse prothorax widest in the middle, by its smaller, less prominent eyes, shorter, more robust male antennæ, and several other minor characters.

Group II.

The extreme southwestern parts of our territory and northern Mexico furnish nearly all the known representatives of this small group; but one species amongst those accessible to me at present extends as far to the eastward as the Texan sea-coast. The species are easily differentiated and may be thus tabulated:—

Legs pale.
  Punctuation excessively dense, the punctures of the pronotum contiguous and the lustre alutaceous.
    Color dark ferruginous, the abdomen black.
      Elytra slightly shorter than wide; together broadly, angularly emarginate at apex .... 5 **dentiger**
      Elytra quadrate, subtruncate behind; body more robust, 6 **mexicanus**
    Color of body black throughout .... 7 **texanus**
  Punctuation more sparse, the punctures of the pronotum distinctly separated in the middle; lustre shining.
    More slender, the apical angles of the prothorax very acute and prominent, the punctures of the pronotum scabrous and dull only very narrowly near the lateral edges; elytra black.
      Lateral angles of the prothorax very narrowly but distinctly rounded.
        Prothorax one-third wider than long and much narrower than the abdomen................................. 8 **armatus**
        Prothorax nearly one-half wider than long and almost as wide as the abdomen.................. ....9 **gilæ**
      Lateral angles of the prothorax angulate, the angle not appreciably rounded ....10 **prominens**
    More robust, the apical angles of the prothorax decidedly less prominent, the punctures of the disk large, contiguous, and scabrous in a very wide area near the sides; black, elytra paler, rufescent ....11 **pacificus**
Legs piceous-black; body black, shining; punctures well separated, 12 **arizonæ**

5 **T. dentiger** n. sp.—Rather slender, moderately depressed, piceous; prothorax and elytra dark red-brown; antennæ and legs throughout pale flavate; finely and extremely densely punctate throughout, more finely so on the abdomen; pubescence dense, extremely fine and short; integuments scarcely shining. *Head* moderate, slightly narrower than the prothorax; antennal prominences pronounced; eyes large, slightly prominent; tempora behind them less than one-half as long, strongly rounded; antennæ moderate, joints two to four gradually and rapidly decreasing in length, second twice as long as wide; club gradual, moderate; tenth joint slightly wider than long. *Prothorax* widest at anterior third, nearly one-half wider than long; sides strongly rounded, almost angulate anteriorly, very strongly convergent and broadly sinuate thence to the base, strongly convergent and feebly arcuate anteriorly to the apical angles which are produced anteriorly, and acute; base broadly, feebly arcuate, two-thirds as wide as the disk, much narrower than the apex; the latter broadly emarginate, bottom of emargination broadly, feebly arcuate; basal angles obtuse, rounded; disk moderately convex; two longitudinal impressions rather distinct; punctures fine and subcoalescent. *Elytra* slightly wider than the prothorax and one-half longer, not as long as wide, each feebly impressed along the sutural bead, which is very fine; punctures fine, separated by their own widths. *Abdomen* slightly narrower than the elytra; sides parallel and very feebly arcuate; border moderate, strongly elevated; surface feebly convex, extremely minutely and densely punctate; pubescence fine, subrecumbent. *Legs* slender; tarsi very short. Length 2.8 mm.

Arizona (Yuma 2; Tuçson 2).

May be distinguished at once by its brown color and alutaceous lustre.

6 **T. mexicanus** n. sp.—Form rather robust and depressed; dark red-brown; abdomen black, with the posterior margin of the two apical segments pale; legs flavate; pubescence very short, fine and rather dense; integuments feebly shining. *Head* distinctly narrower than the prothorax, very minutely, rather feebly and extremely densely punctate, subalutaceous; antennal prominences rather strong and elongate; eyes large, moderately prominent; tempora one-half as long, feebly rounded, not acute and prominent behind. *Prothorax* a little less than one-half wider than long, widest at anterior two-fifths, where the sides are very strongly rounded and subangulate, thence very strongly convergent and very feebly sinuate to the base, and nearly as strongly convergent to the acute and slightly dentiform apical angles; base very feebly arcuate, scarcely two-thirds as wide as the disk; apex truncate between the slightly advanced angles; disk feebly convex, finely, rather feebly and extremely densely punctate; punctures in mutual contact;

lustre subalutaceous; impressions feeble. *Elytra* quadrate, very slightly wider and one-half longer than the prothorax, each rather strongly impressed along the suture; punctures fine and very dense, separated by less than their own diameters. *Abdomen* parallel, distinctly narrower than the elytra; sides feebly arcuate; border moderate; surface feebly convex, very finely and densely punctate, feebly shining. *Legs* slender. Length 2.6 mm.

Mexico (Guanajuato 1). Dr. Eug. Dugès.

The antennæ are missing, but they are probably flavate, as seen in the remaining basal portions, and of the same general structure as in the other representatives of this group. The species resembles *dentiger*, but is more robust, with longer, larger elytra and slightly less dense punctuation, especially on the abdomen.

This species is not mentioned by Dr. Sharp in the Biologia Centrali-Americana.

7 **T. texanus** n. sp.—Rather slender, black; antennæ fuscous, paler toward base; legs throughout flavate: pubescence very short, fine, rather inconspicuous; integuments slightly shining. *Head* narrower than the prothorax, very finely, densely punctate, subalutaceous; antennal tuberculations short, rather feeble: antennæ robust, distinctly longer than the head and prothorax together; joints two to four decreasing uniformly and not very rapidly in length, second more than twice as long as wide, tenth fully as wide as long; club gradual and not strong; eyes large, slightly prominent; tempora but slightly more than one-third as long, narrowly rounded behind. *Prothorax* widest at anterior third, slightly less than one-half wider than long; sides very narrowly rounded at the greatest width, thence strongly convergent and broadly, feebly sinuate to the base, rather less convergent and very feebly arcuate to the acute, prominent and anteriorly projecting apical angles; base broadly arcuate, two-thirds as wide as the disk, much narrower than the apex; the latter transverse, broadly, feebly arcuate, except near the angles, where it is feebly sinuate; disk finely, very densely and subconfluently punctate, feebly shining; impressions rather distinct. *Elytra* slightly wider and nearly one-half longer than the prothorax, scarcely as long as wide, each feebly impressed along the suture; punctures fine, dense, separated by about their own widths; surface shining. *Abdomen* parallel, slightly narrower than the elytra; border rather thick and moderately deep; surface feebly convex, shining, very minutely, densely punctate; pubescence very fine and inconspicuous. *Legs* slender. Length 2.8 mm.

Texas (Galveston 11).

Easily distinguishable from *armatus* by its more robust antennæ, paler legs, denser punctuation, and the tempora not acute and prominent at base; from *dentiger* it may be known by its black color and more shining surface.

8 **T. armatus** n. sp.—Moderately robust and convex, piceous; prothorax slightly paler; antennæ fuscous, scarcely perceptibly paler toward base; legs pale, piceous-brown; pubescence fine, moderate in length, dense; integuments feebly shining. *Head* five-sixths as wide as the prothorax; antennal prominences strong; surface minutely, feebly, and extremely densely punctate, alutaceous; antennæ as long as the head and prothorax, moderately robust, gradually, moderately clavate, all the joints longer than wide, two to four gradually and not very rapidly decreasing in length, second three times as long as wide, tenth just visibly longer than wide; eyes large, moderately prominent; tempora nearly one-half as long, acutely angulate behind. *Prothorax* widest at anterior third, where the sides are very narrowly rounded, thence strongly convergent and nearly straight to the base, feebly convergent and feebly arcuate to the advanced, acute, and prominent apical angles; basal angles obtuse, rounded; base feebly arcuate, scarcely two-thirds as wide as the disk, and scarcely more than three-fourths as wide as the apex; the latter broadly, feebly emarginate, the middle being nearly straight, and with the edge very thin and translucent; disk one-third wider than long, very finely, feebly, and densely punctate; punctures all well separated; impressions strong. *Elytra* distinctly wider and nearly one-half longer than the prothorax, quadrate, each impressed along the suture, rather finely, strongly, and densely punctate; punctures separated by fully their own diameters. *Abdomen* slightly narrower than the elytra; sides parallel and nearly straight; border moderate, rather deep; surface feebly convex, very finely and densely punctate. *Legs* slender. Length 2.3-2.9 mm.

California (Mt. Diablo, San José, Gilroy Hot Springs 3).

The prothorax is rather longer, narrower, and paler in color than in the other species of this vicinity, resembling more nearly the shape of the same part in *dentiger* and *texanus*.

9 **T. gilæ** n. sp.—Moderately slender, very feebly convex, piceous-black; legs brown; antennæ fuscous; pubescence short, very fine, dense, but rather dark in color, and not at all conspicuous; integuments, especially the elytra and abdomen, distinctly shining. *Head* much narrower than the prothorax, broadly convex, minutely, densely punctate; prominences moderate, slightly longer than wide: eyes large, convex, rather prominent; tempora short, parallel, much less prominent, angulate behind, one-third as long as the eye; antennæ slender,

feebly incrassate, but very slightly longer than the head and prothorax, all the joints longer than wide, the tenth slightly so. Prothorax two-fifths wider than long, widest just before anterior two-fifths, where the sides are obtusely subangulate, the angle narrowly, though distinctly rounded, thence moderately convergent and very feebly arcuate to the advanced, acute, and prominent apical angles, slightly more strongly convergent, and scarcely perceptibly sinuate to the basal angles, which are slightly rounded; base feebly arcuate, nearly three-fourths as wide as the disk, much narrower than the apex; the latter broadly, feebly emarginate, the bottom broadly arcuate and very feebly narrowly translucent along the edge; disk strongly bi-impressed; the impressions parallel and strongly constricted; surface finely, deeply, and very densely punctate, the punctures separated by their own widths and abruptly large, scabrous, variolate, and polygonally crowded very near the lateral edges, where also the surface is dull. *Elytra* quadrate, one-fourth wider and two-thirds longer than the prothorax, feebly impressed near the suture, densely punctate, the punctures moderate, separated by scarcely their own widths. *Abdomen* parallel, narrower than the elytra and scarcely wider than the prothorax; sides nearly straight; border moderate; surface minutely, densely punctate. *Legs* moderate. Length 2.7 mm.

Arizona (Tuçson 3).

Also resembles *armatus*, but has a shorter prothorax, with the side angles distinct but narrowly rounded, the surface more densely punctate, the punctures very much deeper and denser, and the surface more alutaceous than in *prominens*.

10 **T. prominens** n. sp.—Moderately slender, parallel, rather depressed, piceous-black; legs pale brownish-flavate; antennæ pale fuscous; pubescence dense, moderate in length; integuments shining. *Head* distinctly narrower than the prothorax, shining, feebly convex, minutely and not very densely punctate; prominences elongate, strong; eyes large, convex, rather prominent; tempora less than one-half as long, angulate behind, not prominent; antennæ slender, very feebly incrassate, about as long as the head and prothorax; joints two to four decreasing uniformly and very gradually, elongate, tenth fully as long as wide. *Prothorax* widest at anterior two-fifths, where the sides are obtusely angulate, the angle not distinctly rounded, thence almost equally and rather strongly convergent to apex and base, just perceptibly arcuate in the former, and just as feebly sinuate in the latter; base feebly arcuate, nearly three-fourths as wide as the disk, much narrower than the apex; the latter broadly, feebly emarginate between the advanced, acute, and prominent anterior angles, the bottom of the emargination broadly arcuate, the edge not at all coriaceous; disk two-fifths wider than long, with two rather narrow, strong median im-

pressions which are distinctly sinuous and slightly convergent posteriorly; surface finely, feebly and densely punctate, the punctures abruptly scabrous and the surface dull very near the lateral edges. *Elytra* quadrate, slightly wider toward apex, one-third wider and one-half longer than the prothorax, impressed near the suture except toward apex, densely, deeply punctate; punctures moderate, separated by scarcely their own widths. *Abdomen* parallel, distinctly narrower than the elytra, sides nearly straight; border moderate; surface minutely and very densely punctate. Length 2.8 mm.

California (Los Angeles 1).

This species, although rather closely rallied to *armatus*, is easily distinguished by its much shorter prothorax, in which the sides are angulate, the angle not being appreciably rounded, by its shape, the widest section being at a greater distance from the apex, and by its rather shorter, and distinctly more slender antennæ.

11 **T. pacificus** n. sp.—Rather robust, moderately convex, piceous-black; elytra slightly rufous; legs throughout and antennæ pale reddish-flavate, the latter slightly infuscate toward apex; pubescence rather long and dense, somewhat coarse and erect; integuments moderately shining. *Head* narrower than the prothorax, finely, feebly, and densely punctate; antennal prominences moderate in length, rather pronounced; antennæ as long as the head and prothorax, rather slender; club moderate; joints two to four decreasing uniformly and very gradually in length, the second twice as long as wide, tenth scarcely as long as wide; eyes large, moderately prominent; tempora one-half as long, strongly rounded throughout the length in circular arc. *Prothorax* widest at anterior two-fifths, where the sides are very strongly rounded and subangulate, thence strongly convergent and nearly straight to the base, slightly less strongly convergent to the apical angles, which are acute and slightly dentiform; basal angles obtuse and narrowly rounded; base almost transversely truncate, fully two-thirds as wide as the disk and distinctly narrower than the apex; the latter truncate; disk two-fifths wider than long, finely punctate; punctures distinctly separated in the middle, large, variolate, scabrous, and polygonally crowded in a broad area at the sides; impressions strong. *Elytra* quadrate, slightly wider and one-half longer than the prothorax, impressed along the suture, rather coarsely and deeply punctate, the punctures separated by slightly more than their own widths. *Abdomen* broad, but slightly narrower than the elytra, parallel; sides feebly arcuate; border moderate, not very deep; surface feebly convex, minutely and feebly reticulate, very minutely and somewhat sparsely punctate. *Legs* slender. Length 2.8 mm.

California (Sonoma Co. 1).

A distinct species, easily known by its more robust form, arcuately rounded tempora, which are not angulate behind, and by its longer, coarser pubescence.

12 **T. arizonæ** n. sp.—Form rather robust; black, legs piceous, tarsi flavescent; antennæ piceous, feebly fuscous toward base; pubescence fine, short and dense, but not conspicuous; integuments rather shining. *Head* narrower than the prothorax, very minutely and moderately densely punctate, smooth, and scarcely at all alutaceous; antennal prominences short and feeble; antennæ slightly longer than the head and prothorax together, slender; club gradual and feeble; outer joints strongly obconical, two to four uniformly and slowly decreasing in length, tenth distinctly longer than wide; eyes rather large, moderately prominent; tempora scarcely more than one-third as long, posterior angle not prominent, but also not rounded, obtuse. *Prothorax* widest at apical two-fifths, where the sides are strongly rounded and subangulate, thence strongly convergent and nearly straight to the base, and almost as strongly convergent to the apex; base broadly, feebly arcuate, two-thirds as wide as the disk, distinctly narrower than the apex; the latter broadly, feebly, and evenly emarginate between the acute and slightly dentiform apical angles; basal angles obtuse, narrowly rounded; disk distinctly less than one-half wider than long, very minutely punctate, shining, the punctures distinctly separated; impressions very feeble, and nearly obsolete. *Elytra* quadrate, distinctly wider, and one-half longer than the prothorax, very feebly impressed along the suture, very finely punctate, the punctures generally separated by a little more than their own diameters. *Abdomen* parallel, broad, but very slightly narrower than the elytra; sides straight; border moderately deep and wide; surface feebly convex, extremely minutely and densely punctate, subalutaceous. *Legs* slender; tarsi very short. Length 2.9 mm.

Arizona (Tuçson 2).

Resembles *armatus*, but differs in its more robust form, finer punctuation, and especially by the very much finer and denser punctuation of the abdomen. It also differs in its less strongly dentiform tempora and anterior angles of the prothorax, the very much more feeble pronotal impressions, and the more strongly obconical and slightly more elongate outer joints of the antennæ.

Group III.

The species here become rather closely allied, and are not easily differentiated by description. The type described below

as *morio* Er. has not been compared with the original, and until this can be done, more or less doubt must attend the indentification.

The following table will serve as a partial guide to the recognition of the comparatively few species represented in my cabinet :—

Sides of the prothorax convergent behind and straight or very nearly so.

Pronotum broadly dull and scabrous laterally, the punctures there being very large, variolate and polygonally crowded. 13 **occiduus**

Pronotum shining, the punctures at the sides larger and denser, but always separated and circular.

Pronotum very broadly and indefinitely impressed or subexplanate at the sides near the middle.

Elytra sparsely punctate.

Eyes very large, the tempora behind them reduced to a small point .. ..14 **quadripunctatus**

Eyes smaller, the tempora very distinct.......15 **conjunctus**

Elytra densely punctate; tempora distinct........ ....16 **morio**

Pronotum either not impressed laterally, or very narrowly and indefinitely so along the margin behind the middle.

Eyes moderate, not very prominent and more finely faceted, the tempora nearly one-half as long.. ... .17 **spretus**

Eyes large, prominent, very coarsely faceted; the tempora short, always less than one-third as long as the eye.

Elytra very densely punctate................18 **apacheanus**

Elytra more coarsely and sparsely punctate.

Pronotum very finely, densely punctate.... ....19 **mancus**

Pronotum sparsely punctate and more polished.

More robust; sides of prothorax more narrowly rounded. 20 **spectatus**

More slender; sides of prothorax very broadly rounded and coarctate to the apex ... .21 **imbellis**

Sides of prothorax convergent behind and broadly, distinctly arcuate. 22 **lepidus**

The terms *large, moderate, prominent,* etc., relating to the eye are of course simply comparative within the limits of the group.

13 **T. occiduus** n. sp.—Moderately robust, black; legs and antennæ throughout rather pale reddish-brown; pubescence very fine, rather short, subrecumbent and moderately dense; integuments shining.

Head four-fifths as wide as the prothorax, feebly convex, finely, rather feebly, very densely punctate; prominences short, strong; antennæ moderate, feebly incrassate; joints two to four almost uniformly and very rapidly decreasing in length, tenth slightly longer than wide; eyes large and comparatively finely granulated, slightly prominent; tempora one-third as long, strongly rounded, not angulate. *Prothorax* one-half wider than long, widest at anterior third, where the sides are broadly rounded, thence feebly convergent and feebly arcuate to the apex, and much more strongly convergent and scarcely perceptibly arcuate to the base; the latter broadly arcuate, three-fourths as wide as the disk; narrower than the apex which is transversely truncate; apical angles obtuse, very narrowly rounded; basal obtuse and more broadly rounded; disk rather densely punctate, shining in the middle, dull at the sides; punctures in the middle very fine and separated by twice their own widths, gradually coarser laterally, and, near the sides, very large, shallow, variolate and polygonally crowded; median impressions moderate; not impressed laterally. *Elytra* quadrate, very slightly wider and nearly one-half longer than the prothorax, distinctly impressed near the suture, rather coarsely, feebly punctate; punctures separated by fully their own diameters. *Abdomen* parallel, slightly narrower than the elytra; sides feebly arcuate; border moderate in width and depth; surface finely subgranulose, shining, minutely and not very densely punctate. *Legs* slender. Length 3.0 mm.

California (San Mateo Co. 2). Mr. C. Fuchs.

This is a very distinct species in pronotal sculpture.

A specimen from Humboldt Co. agrees very well, differing only in having the prothorax a little shorter, with the sides slightly less strongly convergent toward base, but it also appears to differ sexually.

14. **T. quadripunctatus** Say.—*Stenus quad.* Say; Tr. Am. Phil. Soc., IV., p. 459.—Moderately robust and convex, black; legs piceous; knees and tarsi paler; antennæ piceous throughout; pubescence moderate, rather coarse, and sparse, erect; integuments shining. *Head* nearly one-third narrower than the prothorax, rather finely, feebly, and moderately densely punctate, shining; antennal prominences strong, moderate in length; antennæ slender, distinctly longer than the head and prothorax; club gradual and very slight; second and third joints equal, elongate, third shorter and shorter than the fourth, tenth distinctly longer than wide; eyes very large and prominent; tempora almost obsolete behind them, reduced to a very short point. *Prothorax* nearly two-thirds wider than long, widest near apical third, where the sides are rather strongly rounded, thence strongly convergent and straight to the base, also strongly convergent and distinctly arcuate to

the apex; base broadly, feebly arcuate, two-thirds as wide as the disk, and but just perceptibly narrower than the apex; the latter broadly truncate; basal angles obtuse, narrowly rounded; apical obtuse, but not rounded, and, when viewed sublaterally, very slightly subdentiform; disk feebly convex, strongly impressed, rather finely, deeply, and sparsely punctate, polished, the punctures separated by slightly more than their own widths in the middle, and sparser and coarser toward the sides. *Elytra* quadrate, very slightly wider, and nearly one-half longer than the prothorax, impressed along the suture, coarsely, deeply punctate, polished, the punctures widely separated. *Abdomen* broad, but slightly narrower than the elytra, parallel; sides very feebly arcuate; border rather narrow and deep; surface feebly convex, polished, minutely reticulate, very finely and sparsely punctate. *Legs* slender, tarsi moderate. Length, 2.9–3.2 mm.

Pennsylvania (Allegheny Co. 2); New York (Brooklyn 7). Dr. Hamilton and Mr. H. H. Smith.

A common eastern species, easily identified by its coarse and not dense elytral punctures, shining black integuments, and large eyes, which almost attain the base of the head, differing very greatly in this respect from the others most closely allied to it.

This formation of the sides of the head behind the eyes cannot, however, be confounded with that of Group V, where the neck begins at the eyes, generally without any nuchal constriction; here the constriction is well marked, extending across the head at some distance behind the eyes.

The species *morio* of Erichson (Gen. Staph., p. 805) cannot be the same as this, as the elytral punctures are stated to be very dense (creberrime) in the former. These punctures in *quadripunctatus* are unusually coarse, but at the same time unusually sparse.

Haploderus laticollis of Le Conte (New Species Col., 55) is identical with this species. It was described from a specimen so excessively immature that the disk of the pronotum is drawn entirely out of the usual form, presenting a broad impression on the left and an equally broad but interrupted one on the right, the two being separated by a decided ridge. The surface of the abdomen is shrunken in such a way as to leave the sides vertical and very deep, presenting the appearance of the same part in Oxytelus. This appearance of the abdomen is due entirely to

immaturity and shrinkage of the integuments, as it is equally evident in several specimens of *caloderinus* and in one of *difficilis* which I have before me. The general outline and punctuation—which are the only characters remaining for comparison—correspond entirely with *quadripunctatus*.

15. **T. conjunctus** n. sp.—Rather robust, black; legs black; knees and tarsi slightly paler; antennæ throughout and palpi black; pubescence rather short, fine, and sparse; integuments shining. *Head* four-fifths as wide as the prothorax, feebly convex, finely, densely punctate; prominences rather large and feeble; antennæ very slightly longer than the head and prothorax, rather robust, gradually and moderately incrassate from the second joint; two to four uniformly and rapidly decreasing in length, the latter distinctly elongate, tenth slightly longer than wide; eyes large, coarsely faceted, slightly prominent; tempora one-third as long, strongly rounded throughout to the neck. *Prothorax* one-half wider than long, widest just behind apical third, where the sides are rather strongly rounded, thence strongly convergent and straight to the base, and slightly less strongly convergent and very feebly arcuate to the apical angles, which are obtuse and not rounded; basal angles obtuse, very narrowly rounded; base feebly arcuate, a little more than two-thirds as wide as the disk, distinctly narrower than the apex; the latter transversely truncate; disk rather finely, densely punctate, the surface finely granulose and subopaque toward the sides, with the punctures much larger, but not much closer; median impressions moderate or rather feeble; surface also distinctly impressed at each side in the middle and very near the edge. *Elytra* quadrate, nearly one-fourth wider and one-half longer than the prothorax, feebly impressed along the suture, rather coarsely and sparsely punctate, the punctures separated by fully twice their own widths. *Abdomen* broad, very slightly narrower than the elytra, parallel; sides feebly arcuate; border thick and rather shallow; surface feebly convex, minutely granulose, shining, minutely and not very densely punctate. *Legs* slender. Length, 3.0 mm.

Oregon 1. Mr. O. Lugger.

A comparatively large species, related to *quadripunctatus*, but differing in its smaller eyes, denser, coarser, pronotal punctuation, which is also more scabrous toward the sides, its finer elytral punctuation, and finer, denser abdominal pubescence.

16. **T. morio** Er.—Gen. Staph., p. 805.—Moderately robust, black; legs piceous-brown, tibiæ especially toward apex and tarsi paler; antennæ piceous, rufo-piceous toward base; pubescence very short, but rather coarse and sparse, not conspicuous; integuments polished.

Head one-fourth narrower than the prothorax, rather convex, finely, feebly, rather densely punctate, shining; prominences short, strong; antennæ very slender, as long as the head and prothorax; club very gradual and feeble; joints two to four, decreasing uniformly, very rapidly in length, the latter distinctly longer than wide, tenth very slightly longer than wide; eyes moderate, not very prominent, rather more finely faceted than usual; tempora nearly one-half as long, strongly rounded and slightly prominent. *Prothorax* widest at anterior two-fifths; sides evenly rounded and coarctate to the apical angles, which are obtuse, not rounded, and very slightly and laterally dentiform when viewed sublaterally, strongly convergent and straight to the base, which is very feebly arcuate, two-thirds as wide as the disk, and distinctly narrower than the apex; the latter truncate; basal angles obtuse, slightly rounded; disk one-third wider than long, feebly convex, finely, rather sparsely punctate in the middle, the surface becoming more granulose toward the sides, and with the punctures larger but still rather sparse; impressions distinct. *Elytra* distinctly wider and two-fifths longer than the prothorax, quadrate, each feebly impressed along the suture, somewhat coarsely and densely punctate. *Abdomen* distinctly narrower than the elytra, parallel; sides very feebly arcuate; border moderately thin and deep; surface feebly convex, shining, minutely granulose, sparsely and very minutely punctate. *Legs*, slender. Length, 3.0 mm.

New York 1. Dr. Hamilton.

The more broadly, evenly rounded sides of the prothorax anteriorly easily distinguish this and the following species from *quadripunctatus* Say. This species is further distinguished from the others of this immediate part of the genus by its much sparser abdominal punctuation.

17 **T. spretus** n. sp.—Rather slender, black; legs throughout pale rufo-testaceous; antennæ piceous-brown, gradually rufo-testaceous toward base; pubescence short, fine, sparse; integuments polished. *Head* rather small, scarcely three-fourths as wide as the prothorax, rather convex, finely, feebly, moderately densely punctate; prominences strong; antennæ distinctly longer than the head and prothorax, slender, very feebly incrassate; second joint slender, elongate, distinctly longer than the third, the latter subequal to the fourth, nearly twice as long as wide, tenth very slightly longer than wide; eyes rather large, moderately prominent, not very coarsely granulate; tempora strongly rounded and about one-half as long as the eye. *Prothorax* widest just behind anterior third, where the sides are evenly rounded, and thence coarctate to the apex, and strongly convergent and straight to the base; the latter feebly arcuate, nearly three-fourths as wide as the disk and slightly

narrower than the apex; the latter truncate; apical angles obtuse, not rounded; disk one-third wider than long, finely, sparsely punctate, the punctures larger and but slightly denser along the sides; impressions distinct, feebly arcuate. *Elytra* quadrate, slightly wider and nearly one-half longer than the prothorax, feebly impressed near the suture, rather coarsely punctate, the punctures separated by twice their own diameters. *Abdomen* parallel, slightly narrower than the elytra and wider than the prothorax; sides very feebly arcuate; border moderate; surface minutely and feebly reticulate, minutely and not very densely punctate. *Legs* slender. Length 2.7 mm.

Pennsylvania, Maryland, and North Carolina 6.

The head is rather smaller and the eyes less prominent than in the following species. It appears to be common in the mountainous regions of the Atlantic States.

18 **T. apacheanus** n. sp.—Moderately robust and convex, black; legs piceous-black; antennæ piceous-brown, but very slightly paler toward base; pubescence very short, fine, and rather dense; integuments feebly shining, the abdomen subalutaceous. *Head* distinctly narrower than the prothorax, feebly convex, finely, densely, and rather strongly punctate; antennæ slightly longer than the head and prothorax, slender; club gradual and feeble; joints two to four uniformly and slowly decreasing in length, the latter decidedly elongate and obconical, tenth slightly longer than wide, obconical; antennal prominences strong; eyes large and prominent, moderately convex; tempora short, one-fourth as long, obtusely angulate behind. *Prothorax* two-fifths wider than long, widest at apical third, where the sides are evenly rounded, and thence coarctate to the apex, and strongly convergent and nearly straight to the base; the latter feebly arcuate, nearly three-fourths as wide as the disk and much narrower than the apex; the latter transversely truncate; apical angles obtuse, not rounded; basal less obtuse, slightly rounded; disk rather finely, densely, and evenly punctate throughout, the punctures separated by slightly more than their own diameters; impressions rather feeble. *Elytra* quadrate, distinctly wider and one-half longer than the prothorax, each feebly impressed along the suture, moderately coarsely, deeply and densely punctate; punctures separated by slightly more than their own widths. *Abdomen* slightly narrower than the elytra, parallel; sides nearly straight; border rather thick and shallow; surface feebly convex, finely reticulate, minutely and rather densely punctate. *Legs* slender; tarsi moderate. Length 3.0 mm.

Arizona (Tuçson 6).

The abdominal punctures are separated by about one-half the

distance of those in *morio*, and it may be distinguished from all the others of this portion of the group by its finer and denser elytral punctuation.

The legs are paler in some specimens, of which the type is one, being reddish-brown; this character should therefore be used with caution, and only when confirmed by large series of specimens.

19 **T. mancus** n. sp.—Moderately slender, black; legs dark piceous brown; antennæ piceous, apex of first and base of second joints paler; pubescence short, fine, rather dense; integuments shining. *Head* four-fifths as wide as the prothorax, feebly convex, minutely and densely punctate; prominences rather small and feeble; antennæ slender, longer than the head and prothorax, very slightly incrassate; joints two or four decreasing in length, the latter distinctly elongate, tenth slightly longer than wide; eyes very large and coarsely granulated, prominent; tempora very short, one-fourth as long, obtusely subangulate, not prominent. *Prothorax* fully one-half wider than long, widest at anterior two-fifths, where the sides are rather broadly rounded, thence almost equally and rather strongly convergent to base and apex, and very feebly arcuate in the latter sense; base broadly feebly arcuate, two-thirds as wide as the disk, much narrower than the apex; the latter truncate; apical angles obtuse, not distinctly rounded; basal obtuse and slightly rounded; disk distinctly impressed, finely and densely punctate, the punctures separated by less than twice their widths, and becoming rather abruptly slightly larger and closer with the surface strongly, finely reticulate near the sides. *Elytra* quadrate, a little wider and one-half longer than the prothorax, scarcely perceptibly impressed near the suture, except a very feeble mutual impression at the base, somewhat coarsely but feebly punctate, the punctures separated by nearly twice their own widths. *Abdomen* much narrower than the elytra, parallel; sides nearly straight; border rather thin and deep; surface minutely reticulate, the reticulations almost granulose, also minutely and rather sparsely punctate. *Legs* slender, short as usual. Length 2.5 mm.

Texas (locality not specified 2). U. S. National Museum.

This species was identified as *memnonius* Er. by M. Fauvel, but it probably differs in the antennæ, which are described by Erichson as being a little shorter than the head and prothorax; here they are distinctly longer.

20 **T. spectatus** n. sp.—Very slightly more robust, black; legs and antennæ very dark brownish-piceous, the latter scarcely paler at base; pubescence short, very fine, and rather sparse; integuments shining. *Head* fully four-fifths as wide as the prothorax, nearly flat above,

finely, densely punctate, shining, the punctures distinctly separated; prominences small, moderate; antennæ much longer than the head and prothorax, very slender and very feebly incrassate; joints two to four decreasing very slowly in length, elongate, tenth very decidedly longer than wide; eyes very large, prominent; tempora very short, less than one-third as long, strongly rounded. *Prothorax* widest at anterior third, where the sides are rather strongly, evenly rounded, thence nearly equally and rather strongly convergent to base and apex, straight in the former sense, feebly arcuate in the latter; base feebly arcuate, two-thirds as wide as the disk, much narrower than the apex; the latter truncate; apical angles obtuse, not rounded; basal obtuse and distinctly rounded; disk feebly convex, distinctly impressed, finely and sparsely punctate, the punctures separated by from three to four times their widths, and, near the sides, about twice as large and separated by but slightly more than their own dimensions, the surface not becoming less polished. *Elytra* quadrate, very slightly wider and one-half longer than the prothorax, feebly impressed near the suture, rather coarsely and deeply punctate; punctures separated by more than once and less than twice their own diameters, slightly sparser laterally. *Abdomen* parallel, distinctly narrower than the elytra; sides nearly straight; border moderate; surface minutely reticulate, also minutely and somewhat densely punctate. *Legs* slender. Length 2.6 mm.

Florida (Sand Point and Tampa 2). Mr. E. A. Schwarz.

Very easily distinguished from *mancus*, in which the eyes are also very large, by its much sparser pronotal punctuation and many other characters.

This species has also been identified as *memnonius* Er. by M. Fauvel.

21 **T. imbellis** n. sp.—Rather slender, black; legs red-brown; antennæ fuscous, slightly paler at base; pubescence moderate in length, rather coarse and dense; integuments shining. *Head* three-fourths as wide as the prothorax, very feebly convex, rather finely, densely punctate; prominences moderate; antennæ longer than the head and prothorax, slender, feebly incrassate; joints two to four uniformly and slowly decreasing in length, the latter elongate, more than twice as long as wide, tenth joint distinctly longer than wide; eyes large, prominent, very coarsely faceted; tempora short, strongly rounded, but slightly prominent, not quite one-third as long as the eye. *Prothorax* two-fifths wider than long, widest just behind anterior third, where the sides are evenly rounded, and thence coarctate to the apex, strongly convergent and straight to the base; the latter broadly arcuate, fully two-thirds as wide as the disk, much narrower than the apex; the latter truncate; apical angles broadly obtuse; basal slightly rounded; disk rather finely punctate in the middle, where the punctures are separated

by fully twice their own diameters, almost three times as wide at the sides where they are very narrowly separated, but scarcely polygonally crowded, impressions distinct, broad, even. *Elytra* nearly quadrate, a little wider and nearly one-half longer than the prothorax, transversely, rather strongly convex, very feebly impressed near the suture toward base, rather coarsely and strongly punctate, the punctures separated by slightly less than twice their own widths. *Abdomen* parallel, slightly narrower than the elytra; sides feebly arcuate; border moderate; surface very feebly reticulate, minutely and moderately densely punctate. *Legs* slender. Length 2.4 mm.

Iowa (exact locality unknown 1). Mr. Otto Lugger.

Differs from *spectatus*, which it resembles in general characters, in its more slender form, generally denser and more uneven pronotal punctuation, and the more broadly rounded sides of the prothorax.

22 **T. lepidus** n. sp.—Rather slender, black; legs throughout pale rufo-testaceous; antennæ piceous-black, feebly rufous at base; pubescence short, not very dense; integuments shining. *Head* moderate, rather convex; antennal prominences short and strong; antennæ distinctly longer than the head and prothorax, slender, very feebly incrassate; joints two to four uniformly and rather rapidly decreasing in length, the latter one-third longer than wide; eyes large, moderately prominent and more finely faceted than usual: tempora short, strongly rounded, one-third as long. *Prothorax* one-third wider than long; sides broadly rounded anteriorly, coarctate to the apex, rather strongly convergent and distinctly, evenly arcuate to the base, the latter very feebly arcuate, two-thirds as wide as the disk, much narrower than the apex, the latter truncate; apical angles scarcely rounded; basal more strongly so; disk widest at anterior two-fifths, rather convex, finely, rather densely punctate, the punctures separated by about twice their own widths, larger and denser at the sides; impressions distinct, slightly subinterrupted in the middle. *Elytra* quadrate, distinctly wider and two-fifths longer than the prothorax, very feebly impressed near the suture toward base, rather coarsely, strongly, and unevenly punctate, the punctures much finer and sparser laterally and toward apex, rather dense toward suture and base. *Abdomen* parallel, very slightly narrower than the elytra and slightly wider than the prothorax; sides feebly arcuate; border moderate; surface finely subgranulose, feebly shining, minutely and rather sparsely punctate. *Legs* slender. Length 2.4 mm.

Iowa (Cedar Rapids 1). Dr. E. Brendel.

This very distinct species is to be easily identified by its rounded converging sides of the prothorax, pale legs, piceous antennæ and rather more finely faceted eyes.

Group IV.

As far as ease of classification is concerned, the species of the present group are by far the most interesting of the genus; they are for the most part widely separated among themselves, both in appearance and structural characters. The group contains the largest and the smallest representatives of the genus, and such forms as *lithocharinus*, *ingens*, and *brachypterus* stand out as markedly distinct types, perhaps connecting the genus to its earlier and at present extinct allies. The adopted classification follows:—

Eyes small or at most moderate, the tempora not less than two-thirds as long as the eye.
- Pronotum coarsely and sparsely punctate, transverse.
  - Elytra longer than wide and about twice as long as the prothorax.
    - Elytral punctures denser; pronotal impressions very evident. 23 **diffusus**
    - Elytral punctures sparser; pronotal impressions very feeble. 24 **lapsus**
  - Elytra nearly as long as wide, much longer than the prothorax. 25 **phlœoporinus**
  - Elytra much shorter than wide and but very slightly longer than the prothorax ....26 **egregius**
- Pronotum much more finely and densely punctate.
  - Prothorax much wider than long, strongly rounded at the sides anteriorly.
    - Elytra longer than wide; form depressed; extremely minutely, densely punctate and pubescent; pronotum scarcely perceptibly impressed...........................27 **lithocharinus**
    - Elytra quadrate or shorter, but distinctly longer than the prothorax.
      - Pronotum very distinctly bi-impressed.
        - The impressions strongly subinterrupted in the middle of their length; antennæ short or moderate, not longer than the head and prothorax.
          - Elytra subquadrate.........................28 **obliquus**
          - Elytra slightly wider than long.
            - Legs and antennæ deep black.............29 **sculptilis**
            - Legs rufous; antennæ fuscous..............30 **difficilis**
        - The impressions not interrupted.
          - Antennæ long, conspicuously longer than the head and prothorax; size large; head small ....31 **congener**

Antennæ short, not longer than the head and prothorax; size small; head almost as wide as the prothorax.
32 **agonus**

Pronotal impressions feeble and not at all conspicuous.

Elytra short, much wider than long.

Antennæ short, about as long as the head and prothorax.
33 **temporalis**

Antennæ long, fully attaining the middle of the elytra.
34 **probus**

Elytra quadrate or very slightly shorter than wide.

Form slender; legs piceous; antennæ fuscous, 35 **nanulus**

Form more robust; legs and antennæ pale flavate.
36 **modestus**

Elytra very short, subequal in length to the prothorax; integuments very finely, strongly granulose and completely dull.
37 **brachypterus**

Prothorax very slightly wider than long, very feebly or not at all impressed.

Sides of prothorax very broadly and almost evenly arcuate, being feebly convergent from apex to base; small, extremely slender species.

Antennæ short, not longer than the head and prothorax.

Piceous; elytra paler, rufescent ... ... 38 **pertenuis**

Piceous-black throughout....... ....39 **detractus**

Antennæ more slender, distinctly longer than the head and prothorax. ....40 **indigens**

Sides of prothorax strongly rounded anteriorly, convergent and nearly straight toward base; size very large.

Very slender, linear; pronotum granulose, densely and rather indistinctly punctate; elytra rather finely and much more sparsely punctate ....41 **graphicus**

More robust, linear; pronotum and elytra coarsely, deeply, and subconfluently punctate............. ....42 **ingens**

Eyes larger; the tempora not more than one-half as long.

Tempora not less prominent than the eye ....43 **incertus**

Tempora very distinctly less prominent than the eye.. 44 **delicatus**

The number of undiscovered forms in this group probably exceeds that of all the others combined; under these circumstances it is impossible to prevent doubt on the part of one attempting to identify any independent collection by its means alone. Ambiguity may possibly be considerably lessened by making full use of the descriptions which follow, and to which alone the above table is intended to serve as a key.

23 **T. diffusus** n. sp.—Slender, deep black throughout the body, legs, antennæ, and oral organs; pubescence short, fine, and sparse; integuments shining. *Head* very slightly narrower than the prothorax, slightly wider than long, broadly convex, very coarsely and somewhat sparsely punctate; prominences small, moderate; antennæ robust, about as long as the head and prothorax, abruptly clavate; second joint rather robust, twice as long as wide, one-half longer than the third, the latter very slightly longer than the fourth, which is scarcely as wide as long, tenth slightly transverse; eyes small, very feebly convex, finely faceted; tempora fully as long as the eye, broadly rounded and not very prominent. *Prothorax* nearly one-half wider than long, widest at anterior third, where the sides are moderately broadly rounded and nearly coarctate to the apex, convergent and straight toward base; the latter feebly arcuate, fully three-fourths as wide as the disk and rather distinctly narrower than the apex, which is transversely truncate; apical angles obtuse, not rounded; basal distinctly rounded; disk with two straight, feeble, longitudinal impressions, the entire surface finely reticulate, but more strongly so in the impressions and near the sides, very coarsely and sparsely punctate, the punctures round, very shallow, variolate, nearly one-half as wide as the third antennal joint, and separated by from once to twice their own diameters. *Elytra* distinctly longer than wide, one-third wider than the prothorax, and about twice as long; humeri right, very narrowly rounded: surface of each feebly impressed along the suture, rather coarsely, deeply punctate; the punctures impressed, much deeper, but not as large as those of the prothorax, separated by nearly twice their own widths. *Abdomen* slightly narrower than the elytra, parallel; sides very feebly arcuate; border thin and rather deep; surface feebly convex, finely reticulate, minutely and rather sparsely punctate. *Legs* short, slender; tarsi rather long. Length 2.5 mm.

California (Truckee, Nevada Co. 1).

No comparative remarks are necessary to distinguish this very distinct species from any other here described.

24 **T. lapsus** n. sp.—Rather robust, feebly convex, piceous-black throughout; antennæ, legs, and trophi same; pubescence short, rather coarse and very sparse; integuments polished. *Head* very slightly narrower than the prothorax, wider than long, broadly convex, coarsely and sparsely punctate; prominences moderate in size, strong; antennæ very robust, about as long as the head and prothorax; club strong; second joint scarcely more than one-half longer than wide and very slightly longer than the third, fourth slightly wider than long; outer joints transverse; eyes rather small and moderately finely faceted, somewhat convex, very slightly prominent; tempora nearly as long and almost as prominent, broadly rounded. *Prothorax* one-third wider than long,

widest near the apex, where the sides are narrowly rounded and coarctate to the apical angles, which are laterally prominent and minutely, feebly dentiform, moderately convergent and feebly arcuate to the base, which is feebly arcuate, fully four-fifths as wide as the disk and slightly narrower than the apex; the latter broadly and distinctly arcuate throughout the width; disk not distinctly impressed, but feebly tumid along the middle toward base, coarsely and very sparsely punctate. *Elytra* one-half wider and four-fifths longer than the prothorax, slightly longer than wide, feebly impressed near the suture toward base, rather coarsely and very sparsely punctate, the punctures slightly smaller than those of the pronotum, but deeper and equally sparse. *Abdomen* distinctly narrower than the elytra; sides nearly parallel and straight; border rather narrow and deep; surface feebly reticulate, finely, rather sparsely punctate, the punctures distinctly subasperate. *Legs* moderate. Length 2.2 mm.

California (Truckee, Nevada Co. 1).

A very distinct species in its somewhat robust form, small prothorax, coarse, very sparse punctures, black, robust antennæ and distinctly asperate abdominal punctures, this last character being of very unusual occurrence. The tempora are very broadly and feebly arcuate, and, as the eye is but very slightly prominent, there is less of an emargination between the eye and tempus than is usual in this part of the group.

25 **T. phlœoporinus** Lec.—Trans. Am. Ent. Soc., VI., p. 246 — Slender, rather convex, castaneous; abdomen piceous-black; legs pale rufo-testaceous; antennæ same toward base, more infuscate toward apex; pubescence rather coarse, short, very sparse; integuments shining. *Head* very slightly narrower than the prothorax, slightly wider than long, rather convex, polished, very coarsely and sparsely punctate, the punctures wanting in the middle; prominences moderate; antennæ not very robust, about as long as the head and prothorax, rather abruptly and moderately clavate; joints two to four almost uniformly and very rapidly decreasing in length, the former slightly robust and nearly twice as long as the latter, which is scarcely as long as wide, tenth distinctly wider than long; eyes very small, rather finely faceted, very feebly convex, not very prominent; tempora as long as the eye and about equally prominent, broadly rounded. *Prothorax* widest at anterior third, where the sides are obtusely subangulate and very slightly rounded, thence convergent and straight to the base, and slightly less convergent and feebly arcuate to the apical angles, which are obtuse and not rounded; basal slightly rounded; base broadly arcuate, scarcely three-fourths as wide as the disk and distinctly narrower than the apex; the latter truncate; disk two-fifths wider than long, extremely ob-

soletely bi-impressed, very coarsely and sparsely punctate, the punctures shallow, variolate, separated by from once to twice their own widths, not appreciably larger or denser laterally. *Elytra* scarcely as long as wide, just visibly wider and one-third longer than the prothorax, strongly impressed near the suture; surface transversely rather convex, feebly, coarsely rugulose, coarsely and sparsely punctate, the punctures nearly as large as those of the prothorax and equally sparse. *Abdomen* parallel, not narrower than the elytra; sides straight; border narrow, moderately deep; surface feebly convex, feebly reticulate, minutely and rather sparsely punctate. *Legs* slender. Length 2.6 mm.

Iowa (Cedar Rapids 2). Dr. E. Brendel.

A very coarsely and sparsely punctured species, remarkable for its parallel sides and slender form; it is very distinct from any other known to me.

The type in the cabinet of Dr. Le Conte is immature. The phrase "prothorax not wider than long" occurring in the original description is evidently the result of an oversight.

26 **T. egregius** n. sp.—Slender, slightly convex, black; legs piceous, the knees and tarsi paler; antennæ black; pubescence fine, short, and very sparse; integuments shining. *Head* slightly narrower and longer than the prothorax, rather convex, somewhat coarsely, feebly, and sparsely punctate, distinctly more granulose laterally; eyes moderate, slightly prominent, very coarsely faceted; tempora slightly shorter, rounded and rather more prominent; antennæ short, about as long as the head and prothorax, gradually and rather strongly clavate: outer joints strongly transverse and slightly perfoliate; second nearly as long as the next two together and distinctly more robust, less than twice as long as wide, fourth much shorter than the third and rather strongly transverse. *Prothorax* widest in the middle, nearly two-thirds wider than long; sides very obtusely angulate, extremely feebly convergent and very feebly arcuate in the apical half, rather strongly convergent and straight in the basal; base very feebly arcuate, nearly three-fourths as wide as the disk; apical angles obtuse, but not rounded; apex broadly, feebly arcuate; disk not perceptibly impressed, but very feebly, longitudinally tumid in the middle toward base, very coarsely and sparsely punctate, the punctures scarcely denser toward the sides, where the surface is a little more strongly reticulate. *Elytra* much wider than long, very slightly wider and scarcely one-fourth longer than the prothorax, not at all impressed near the suture, feebly subrugulose, coarsely and sparsely punctate, the punctures subequal in size to those of the prothorax, but deeper and distinctly denser. *Abdomen* in the middle slightly wider than the elytra; sides parallel and feebly arcuate; margin rather fine; surface finely, feebly reticulate,

minutely and sparsely punctate. *Legs* moderately slender. Length 1.5 mm.

Rhode Island (Newport 8).

A very distinct species, not liable to be confounded with any other. It was taken by the author in considerable abundance in the short moss, covering the salt marsh behind the ocean beach, in April. It is not gregarious and its motions are very slow.

27 **T. lithocharinus** Lec.—Trans. Amer. Ent. Soc., VI., p. 245.

The two specimens before me were taken by the writer in Marin Co., California; they agree in every particular with the Le Contean type. As the species is very distinct and not liable to be confounded with any other known to us, the original description will amply serve for its identification.

28 **T. obliquus** n. sp.—Rather slender, moderately convex, black; antennæ throughout and palpi black; legs piceous-black, knees and tarsi very slightly paler; pubescence very fine, short, and sparse; integuments strongly shining. *Head* just visibly narrower than the prothorax, rather convex, densely and somewhat coarsely and deeply punctate; prominences rather large and distinct; antennæ robust, not quite as long as the head and prothorax, rather strongly clavate; second joint more robust and slightly longer than the third, fourth very small, scarcely as long as wide, tenth distinctly wider than long, obconical, ninth abruptly much wider than the eighth; eyes moderate, very slightly prominent, rather finely granulate; tempora nearly as long as the eye, strongly rounded and fully as prominent. *Prothorax* widest a little before the middle, but slightly more than one-third wider than long; sides very broadly rounded anteriorly, convergent and straight in the basal half; basal angles slightly rounded; apical broadly obtuse, not rounded; base feebly arcuate, three-fourths as wide as the disk, much narrower than the apex; disk rather finely, sparsely punctate in the middle, punctures twice as wide, variolate and just visibly separated toward the sides, where the surface is also broadly impressed in the middle; median longitudinal impressions very distinct. *Elytra* quadrate, one-third wider and nearly two-thirds longer than the prothorax, feebly impressed near the suture, coarsely and deeply punctate, the punctures separated by distinctly more than their own diameters. *Abdomen* slightly narrower than the elytra and wider than the prothorax, parallel; sides feebly arcuate; border moderate; surface feebly convex, feebly reticulate, minutely and rather sparsely punctate. *Legs* short, slender. Length 2.3 mm.

California (Lake Tahoe 1).

A very distinct species, easily known by its shining, black integuments and rather coarse, deep elytral punctuation.

29 **T. sculptilis** n. sp.—Moderately slender and convex, black throughout, knees and tarsi very slightly piceo-testaceous; pubescence short, fine, and sparse; integuments shining. *Head* very distinctly narrower than the prothorax, feebly convex, rather finely and densely punctate; prominences short, strong; eyes moderate, rather convex and prominent; tempora about three-fourths as long, strongly, evenly rounded and about as prominent as the eye: antennæ rather short and slender, feebly clavate, about as long as the head and prothorax; second joint as long as the next two together, fourth scarcely longer than wide, tenth slightly transverse. *Prothorax* scarcely one-third wider than long, widest at the middle, where the sides are very obtusely subangulate, thence extremely feebly convergent and nearly straight to the apex, and rather strongly convergent and just perceptibly sinuate to the base, which is feebly arcuate and nearly three-fourths as wide as the disk; apex broadly arcuate and nearly as wide as the disk; the latter very strongly longitudinally bi-impressed, the impressions distinctly subinterrupted, rather finely punctate; punctures feeble, separated by twice their widths, except near the sides, where they are coarser and slightly denser, with the surface more granulose; elevated area between impressions devoid of punctures. *Elytra* slightly wider than long, about one-third wider and longer than the prothorax, rather convex, impressed near the suture, coarsely and deeply punctate, the punctures separated by distinctly more than their own diameters; surface also coarsely and feebly rugulose. *Abdomen* slightly narrower than the elytra; sides parallel and very feebly arcuate; border moderate; surface minutely and feebly reticulate, minutely and rather sparsely punctate. *Legs* slender. Length 2.1 mm.

California (Sonoma and Lake Cos. 13).

Distinguishable by its deep pronotal impressions, which are unusually strong for this division of the genus. It is not closely related to any other species here described.

30 **T. difficilis** n. sp.—Moderately slender and feebly convex, castaneous; elytra piceous; antennæ castaneous; legs slightly paler, ferruginous; pubescence rather short and coarse, moderately dense, finer, sparser on the abdomen; integuments rather shining. *Head* just visibly narrower than the prothorax, rather convex, finely granulose laterally, smoother and finely, sparsely punctate in the middle; prominences rather strong, small; eyes small, somewhat finely faceted, moderately convex; tempora broadly rounded, as long as and slightly more

prominent than the eyes; antennæ rather short and robust, gradually and rather strongly clavate, as long as the head and prothorax; second joint nearly as long as the next two together, but very slightly more robust, twice as long as wide, third much longer than the fourth, the latter about as long as wide, tenth very slightly wider than long. *Prothorax* widest at anterior third, where the sides are broadly rounded and coarctate to the apex, slightly more strongly convergent and very feebly arcuate to the base, which is feebly arcuate, nearly three-fourths as wide as the disk, and much narrower than the apex; the latter transversely truncate; apical angles obtuse, not rounded; disk about one-third wider than long, feebly convex, very strongly, longitudinally bi-impressed, the impressions distinctly subinterrupted, finely and not very densely punctate, the punctures much larger, denser, and more scabrous near the sides. *Elytra* slightly wider than long, one-third wider and longer than the prothorax, rather strongly impressed near the suture, rather coarsely punctate, the punctures separated by nearly twice their own widths, and finer and sparser exteriorly and toward apex. *Abdomen* about as wide as the elytra; sides parallel and decidedly arcuate; border moderate; surface finely reticulate, minutely and sparsely punctate. Length 2.4–2.8 mm.

North Carolina (French Broad River 2); Maryland 3. Mr. Lugger.

The joints two to four of the antennæ may be said to decrease nearly uniformly, and very rapidly in length. The pronotal impressions are very strong, which, together with the coloration of the body, will readily serve to identify this species.

31 **T. congener** n. sp.—Rather slender, black; legs and antennæ throughout piceous; pubescence dense, short, fine; integuments feebly shining. *Head* scarcely three-fourths as wide as the prothorax, rather convex, minutely and extremely densely punctate, subalutaceous; prominences short, strong; antennæ distinctly longer than the head and prothorax, slender, very feebly incrassate; joints two to four uniformly and moderately decreasing in length, the latter decidedly elongate, tenth very slightly longer than wide; eyes rather small, slightly prominent, the tempora two-thirds as long, very strongly arcuate throughout and as prominent as the eyes, not angulate. *Prothorax* nearly one-half wider than long, widest at anterior two-fifths, where the sides are rather broadly rounded; thence rather feebly convergent and slightly arcuate to the apex, and more strongly so and very feebly arcuate to the base; the latter broadly arcuate, two-thirds as wide as the disk, very much narrower than the apex; the latter truncate; apical angles obtuse, feebly, sublaterally dentate; basal obtuse, rather broadly rounded; disk feebly convex, finely, rather deeply and very densely

punctate, the punctures separated by a little more than their own widths, suddenly larger, shallow, variolate, and polygonally crowded near the edge; impressions broad and distinct. *Elytra* quadrate, very slightly wider and nearly one-half longer than the prothorax, feebly impressed near the suture, rather finely and densely punctate; punctures separated by but slightly more than their own diameters. *Abdomen* parallel, distinctly narrower than the elytra; sides very feebly arcuate; border moderate; surface finely reticulate, minutely and rather densely punctate. Length 2.8 mm.

Pennsylvania (Allegheny Co. 1). Dr. Hamilton.

Easily distinguishable by its dense pronotal and abdominal punctuation, and distinct and uninterrupted pronotal impressions.

32 **T. agonus** n. sp.—Slender, rather depressed and linear, piceous; abdomen black; legs and antennæ dark piceous-brown; pubescence short, rather coarse and not very dense; integuments feebly shining. *Head* scarcely perceptibly narrower than the prothorax, wider than long, rather convex, densely punctate; punctures moderately fine, deep, sparser in the middle; prominences small, moderate; eyes small, slightly convex; tempora fully as long as the eye, evenly rounded and distinctly more prominent; antennæ short, about as long as the head and prothorax, not very robust, moderately incrassate; joints two to four very rapidly decreasing in length, the former scarcely twice as long as wide, the latter distinctly transverse, tenth one-third wider than long. *Prothorax* short, nearly three-fifths wider than long, widest just before the middle, where the sides are very broadly, evenly arcuate and coarctate to the apex, more convergent and more feebly arcuate to the base, which is strongly arcuate, the angles being very obtuse and scarcely at all observable; apex much wider than the base, broadly, distinctly arcuate; angles distinctly rounded; disk distinctly bi-impressed, the impressions parallel and not interrupted, densely and somewhat coarsely punctate; punctures somewhat variolate, very distinct, generally separated by about one-third their own diameters, but finer and sparser along the middle; surface broadly, indefinitely impressed laterally. *Elytra* scarcely as long as wide, one-fourth wider and three-fourths longer than the prothorax, distinctly impressed near the suture toward base, somewhat coarsely punctate, the punctures equal in size to those of the pronotum, deep and generally separated by their own diameters. *Abdomen* slightly narrower than the elytra, parallel; sides straight; border moderate; surface minutely and feebly reticulate, very minutely and rather sparsely punctate. Length 1.9 mm.

Tennessee 1. Mr. Otto Lugger.

A distinct species which may be readily known by its small,

transverse, rather coarsely, but very densely punctate prothorax, with the posterior angles not at all evident.

There is no natural division basable on the strength of the pronotal impressions, the character as employed in the table being purely artificial. The species, therefore, although placed near *congener* in the table, is not allied very closely to it except in the strongly marked impressions; in all its other characters, especially including general facies and size, it is a member of the following group of four species ending with *modestus*, and is more particularly similar in outline to *nanulus*.

38 **T. temporalis** n. sp.—Rather slender and convex, black; legs and antennæ piceous, knees and tarsi very slightly paler; pubescence very fine, short, rather sparse; integuments feebly shining. *Head* about as wide as and slightly longer than the prothorax, broadly convex, finely and very densely punctate, subalutaceous; prominences small, very short and rather feeble; antennæ very moderately robust, about as long as the head and prothorax, rather feebly clavate; joints two to four decreasing uniformly and very rapidly in length, the former distinctly more robust, distinctly longer than wide, the latter slightly wider than long, tenth a little transverse; eyes small, slightly convex and prominent; tempora nearly as long, broadly rounded and slightly more prominent. *Prothorax* widest at the middle; sides very broadly, obtusely subangulate, very feebly convergent anteriorly, more strongly so posteriorly; base and apex both broadly, feebly arcuate; base nearly three-fourths as wide as the disk, much narrower than the apex; apical angles obtuse, but scarcely perceptibly rounded; basal more broadly so; disk one-half wider than long, broadly, almost evenly convex; median impressions almost obsolete and barely visible; punctures moderate, slightly irregular, generally separated by more than their own widths, but denser toward the sides and toward base in the median impressions. *Elytra* distinctly shorter than wide, slightly wider and longer than the prothorax, very feebly impressed, rather coarsely, deeply, and unevenly punctate, the punctures separated by from once to twice their own diameters. *Abdomen* as wide as the elytra, parallel; sides nearly straight; border moderate; surface shining, feebly reticulate, minutely and sparsely punctate. *Legs* moderate. Length 1.8 mm.

New York 2, Mr. J. B. Smith; Massachusetts 2, Mr. F. Blanchard.

The short elytra, small eyes, and large tempora will easily distinguish this small but very distinct form.

34 **T. probus** n. sp.—Rather slender, feebly convex, black; legs dark piceous-brown, antennæ dark-brown, slightly testaceous at base and apex; pubescence fine, short, moderately dense, except on the abdomen, where it is very sparse; the latter strongly shining, elsewhere slightly less so. *Head* slightly narrower than the prothorax, feebly convex, minutely and rather sparsely punctate; prominences short, broad, moderate; eyes small, slightly convex, not very prominent; tempora a little longer than the eye and slightly more prominent, broadly rounded; antennæ moderately robust, distinctly longer than the head and prothorax, feebly clavate; second joint distinctly longer and more robust than the third, scarcely twice as long as wide, fourth nearly as wide as long, tenth distinctly wider than long. *Prothorax* a little less than one-half wider than long, widest at anterior two-fifths, where the sides are rather broadly, evenly rounded, coarctate to the apex, moderately convergent and becoming nearly straight toward base; the latter feebly arcuate, nearly three-fourths as wide as the disk, and slightly narrower than the apex; apical angles obtuse and slightly rounded; disk almost imperceptibly bi-impressed, very finely and moderately densely punctate. *Elytra* distinctly wider than long, distinctly wider and nearly one-third longer than the prothorax, very feebly impressed near the suture, rather coarsely and deeply punctate, the punctures separated by more than their own diameters. *Abdomen* fully as wide as the elytra; sides parallel and somewhat strongly arcuate; border rather strong; surface almost smooth and polished, very minutely, sparsely punctate. *Legs* short and slightly robust. Length 2.2 mm.

North Carolina (French Broad River 1).

Peculiar in its rather short elytra, more highly polished abdomen, and coarse elytral punctuation.

35 **T. nanulus** n. sp.—Rather slender, moderately convex, black; legs piceous, tibiæ, tarsi, and antennæ brown; pubescence short, dense, excessively fine and scarcely visible on the head and pronotum, coarser, longer, sparser, and more distinct on the elytra and abdomen; integuments subalutaceous. *Head* very slightly narrower but not longer than the prothorax, strongly convex, extremely minutely and densely punctate; prominences small, moderate; eyes very small, very feebly convex, not prominent; tempora broadly rounded, slightly longer and distinctly more prominent than the eye; antennæ rather robust, as long as the head and prothorax; club distinct; outer joints strongly transverse; second as long as the next two together and distinctly more robust, fourth wider than long. *Prothorax* one-third wider than long, widest slightly before the middle; sides very broadly rounded, coarctate to the apex, more strongly convergent and broadly arcuate to the base; the latter feebly arcuate, nearly three-fourths as wide as the disk, slightly

narrower than the apex; the latter truncate; apical angles slightly obtuse, very narrowly rounded; basal broadly rounded; disk very broadly and extremely feebly bi-impressed, extremely minutely and densely punctate, the punctures throughout the head and pronotum in mutual contact. *Elytra* very slightly wider than long, distinctly wider and one-half longer than the prothorax, very feebly impressed near the suture, rather finely and densely punctate, the punctures more than twice as wide as those of the pronotum, and separated by scarcely their own diameters. *Abdomen* very slightly narrower than the elytra; sides parallel and nearly straight; border moderate; surface minutely, feebly reticulate, and minutely and rather densely punctate. Length 1.5 mm.

Texas (Galveston 5); New Jersey (Cape May 3).

A small species, with very fine, rather dense punctuation and decidedly alutaceous lustre. It is sometimes partially castaneous, with paler legs, probably from immaturity.

On the occiput, in a transverse line midway between the posterior extremity of the eyes and the base of the head, there are two feeble tubercles, mutually slightly more distant than either from the lateral margin; they are excessively minute and only observable under oblique illumination.

The significance of these two minute tubercles is not easy to divine. I have not noticed them elsewhere in the Oxytelini, and they are not evident in some specimens of the present species, which may possibly be females. Perhaps they may constitute a rudimentary beginning or a degradation of the ocelli, which constitute so marked a feature of the great and heterogeneous tribe Omalini.

36 **T. modestus** n. sp.—Rather robust, dark castaneous; abdomen piceous-black; legs and antennæ throughout pale flavate; pubescence very short, moderately dense; integuments rather shining. *Head* large, very slightly narrower than the prothorax, rather strongly convex, finely, densely punctate; punctures less dense in the middle; prominences large, rather strong; eyes moderate and finely faceted, moderately convex and slightly prominent; tempora about two-thirds as long, broadly rounded and nearly as prominent; antennæ short, moderately robust, slightly shorter than the head and prothorax; club strong; second joint nearly as long as the next two combined, fourth scarcely as long as wide, outer joints transverse. *Prothorax* widest slightly before the middle; sides broadly, nearly evenly arcuate from apex to base, slightly straighter and more convergent near the latter, which

is feebly arcuate and about four-fifths as wide as the disk; apex feebly arcuate; apical angles slightly obtuse and not at all rounded; basal rather broadly so; disk one-fourth wider than long, feebly bi-impressed, finely and densely punctate, the punctures separated by more than their own diameters and becoming confused and slightly scabrous near the sides. *Elytra* slightly wider than long, nearly one-fourth wider and over one-half longer than the prothorax, finely and rather densely punctate, the punctures about twice as wide as those of the pronotum, and separated by slightly more than their own widths. *Abdomen* distinctly narrower than the elytra, parallel; sides nearly straight; border rather narrow and deep; surface somewhat finely reticulate, minutely and not very densely punctate; the setæ of the terminal fringes are rather long and coarse. *Legs* moderate. Length 1.7 mm.

Texas (Austin 2).

Very easily known by its short, robust form, rather large head, short, flavate antennæ and rather larger, more finely granulated eyes.

37 **T. brachypterus** Lec.—*Thinobius brach.* Trans. Am. Ent. Soc., VI., p. 240.

This very remarkable species is one of the most minute of the genus. It may be known by its very small, feebly convex eyes, long, feebly arcuate tempora, very short elytra, and dense, dull integuments. Length, 0.6–0.7 mm.

38 **T. pertenuis** n. sp.—Very slender, linear, moderately convex, dark brownish-piceous; elytra pale red-brown; legs and antennæ paler, flavo-testaceous; pubescence minute, fine and moderately dense; integuments somewhat shining. *Head* as wide as the prothorax and about as long as wide, rather convex, minutely and very densely punctate; prominences moderate; eyes rather small, feebly convex and not prominent; tempora about three-fourths as long as the eye, broadly rounded and equally prominent; antennæ short, rather incrassate, slightly shorter than the head and prothorax; second joint slightly shorter than the next two together and a little more robust, fourth wider than long, tenth distinctly wider than long. *Prothorax* very slightly wider than long; sides feebly convergent from apex to base and feebly, nearly evenly arcuate; base feebly arcuate, four-fifths as wide as the apex; the latter subtruncate; apical angles right and very narrowly rounded; basal more broadly so; disk with scarcely a trace of impressions, very minutely punctate, the punctures separated by nearly twice their own widths. *Elytra* distinctly longer than wide, one-third wider and nearly two-thirds longer than the prothorax; sides parallel and straight; disk scarcely perceptibly impressed near the suture,

finely and not very strongly punctate; punctures twice as wide as those of the prothorax and separated by much more than their own diameters. *Abdomen* distinctly narrower than the elytra, very elongate; sides parallel and straight; border moderate, shallow; surface very feebly reticulate, minutely and moderately densely punctate. *Legs* very short. Length 1.7 mm.

Texas (Austin 1).

One of the most slender and elongate species of the genus.

39 **T. detractus** n. sp.—Very slender, linear, piceous-black; elytra almost imperceptibly paler; legs flavate; antennæ fuscous, paler at base; pubescence fine, very short and moderately dense; integuments feebly shining. *Head* as wide as the prothorax, slightly wider than long, rather convex, finely and very densely punctate; prominences moderate; eyes small, feebly convex, and scarcely at all prominent; tempora about as long, broadly rounded and as prominent as the eye; antennæ short, robust, not as long as the head and prothorax; outer joints strongly transverse; second joint as long as the next two together and decidedly more robust, third but slightly longer than wide, fourth transverse. *Prothorax* nearly one-fourth wider than long; sides feebly convergent from apex to base, feebly and almost evenly arcuate; base feebly arcuate, nearly five-sixths as wide as the apex; the latter very feebly arcuate; apical angles very narrowly rounded; basal more broadly so; disk with very slight traces of impressions, minutely and densely punctate; the punctures separated by nearly twice their widths. *Elytra* distinctly wider and about one-half longer than the prothorax, slightly longer than wide, very feebly impressed, very finely and rather densely punctate, the punctures rather larger than those of the pronotum and separated by about twice the interval. *Abdomen* rather broad, but slightly narrower than the elytra, parallel; sides straight; border moderate, very shallow; surface finely reticulate, minutely and rather densely punctate. *Legs* very short and somewhat robust. Length 1.5 mm.

Iowa (Cedar Rapids 2). Dr. E. Brendel.

Closely allied to *indigens*, but differing in its darker color, and especially darker antennæ, in the apical angles of the prothorax, which are here narrowly rounded, in its proportionally shorter tempora, slightly sparser punctuation, and much shorter antennæ. The male is rather more slender than the female, with a distinctly narrower abdomen, but both sexes are slightly more robust and with a proportionally narrower abdominal border than *indigens*.

40 **T. indigens** n. sp.—Very slender, linear, dark castaneous; abdomen piceous; legs, oral organs, and antennæ flavate; pubescence very short, fine, and dense; integuments subalutaceous. *Head* as wide as the prothorax, rather convex, minutely and very densely punctate; prominences small and strong; eyes very small, feebly convex, scarcely at all prominent; tempora distinctly longer, broadly rounded, and equally prominent; antennæ slightly robust and rather strongly capitate, much longer than the head and prothorax; outer joints strongly transverse; second joint slightly shorter than the next two combined, fourth transverse. *Prothorax* about one-fifth wider than long; sides feebly convergent from apex to base, broadly and distinctly arcuate; base feebly arcuate, slightly narrower than the apex; the latter transversely truncate; apical angles nearly right, not in the least rounded; basal slightly rounded; disk with the feeblest possible trace of impressions, minutely and very densely punctate, the punctures separated by nearly their own widths. *Elytra* rather distinctly wider and about two-fifths longer than the prothorax, very slightly longer than wide, scarcely perceptibly impressed near the suture and only toward base; finely and densely punctate, the punctures slightly larger than those of the pronotum and separated by nearly twice the distance. *Abdomen* long and parallel, slightly narrower than the elytra; sides straight; border moderate, shallow; surface finely reticulate, minutely and densely punctate. *Legs* very slender. Length 1.5–1.7 mm.

Rhode Island (Newport 10).

I found a small colony of this gregarious species on the under side of a stone, imbedded in the damp bottom of a partially dry ditch, in April. Its motion is very slow.

As in many species of this genus, especially the smaller and more slender, the antennæ are distinctly perfoliate.

41 **T. graphicus** n. sp.—Very slender, linear, moderately convex, piceous; elytra slightly rufous; apical margin of the last two segments paler; legs dark rufo-testaceous; antennæ fuscous, paler at base and apex; pubescence short, rather coarse, moderately dense; integuments dull, the elytra rather shining. *Head* slightly narrower than the prothorax, feebly convex, strongly granulose, rather coarsely, very feebly, and somewhat densely punctate; prominences rather large; eyes moderate, feebly convex, coarsely faceted; facets strongly convex; tempora about three-fourths as long, broadly rounded, as prominent as the eye; antennæ rather slender, very feebly incrassate, slightly longer than the head and prothorax; joints two to four uniformly and very rapidly decreasing, the fourth slightly longer than wide and one-half as long as the second, tenth as wide as long. *Prothorax* very slightly wider than long, widest at anterior two-fifths; sides rather strongly rounded and

almost evenly coarctate to the apex, moderately convergent and nearly straight toward base; the latter feebly arcuate, less than three-fourths as wide as the disk, very much narrower than the apex; the latter broadly arcuate; apical angles obtuse, but scarcely rounded; disk with the feeblest possible trace of two broad longitudinal impressions, feebly convex, finely, densely, and strongly granulate, coarsely, very feebly, densely, and indistinctly punctate, the punctures slightly separated. *Elytra* quadrate, slightly wider and two-fifths longer than the prothorax, feebly impressed near the suture, which is narrowly but strongly elevated, moderately coarsely, subasperately punctate, the punctures separated by nearly twice their widths; interspaces not granulose, shining. *Abdomen* slightly wider behind, at base distinctly narrower than the elytra; sides almost straight; border thick and shallow; segments transversely and rather more than usually impressed at base; surface finely, rather strongly reticulo-granulose, feebly shining, minutely, sparsely, and not distinctly punctate. *Legs* somewhat robust. Length (strongly extended) 3.8 mm.

Missouri 1.

The granules of the pronotum are very strong, fine, and dense, giving an absolutely dull surface on which the punctures are very indistinct; these under sufficient power are seen to be merely small circular areolæ, very shallow and with the bottom smooth and shining.

42 **T. ingens** n. sp.—Moderately slender, linear, black; legs dark rufous; antennæ fuscous, rufous at base; pubescence short, coarse, moderately dense; integuments dull. *Head* about four-fifths as wide as the prothorax, not very convex, coarsely and very densely punctate; prominences large, moderate in elevation; eyes small but rather convex, slightly prominent; tempora fully as long, rather strongly rounded and almost as prominent as the eye; antennæ slightly longer than the head and prothorax, rather robust and moderately incrassate, all the joints longer than wide; two to four uniformly and very gradually decreasing in length. *Prothorax* widest at anterior third, about one-fifth wider than long; sides anteriorly rather strongly, evenly rounded and coarctate to the apex, rather strongly convergent and straight to the base, which is feebly arcuate, scarcely three-fourths as wide as the disk, and much narrower than the apex; the latter subtruncate; apical angles obtuse, slightly rounded; basal more broadly so; disk not perceptibly impressed, rather depressed in the middle, coarsely and extremely densely punctate, the punctures subconfluent. *Elytra* quadrate, slightly wider and two-fifths longer than the prothorax; feebly impressed near the suture, coarsely and very densely punctate, the punctures equal in size to those of the pronotum, but slightly deeper, some-

what subconfluent. *Abdomen* at base slightly narrower than the elytra, slightly wider behind; sides straight; border very thick but not very deep; surface minutely granulose, rather coarsely, very densely punctate toward base, more sparsely so toward apex. *Legs* short and very robust. Length 4.2 mm.

Iowa (Cedar Rapids 1); Illinois 2. Dr. Brendel and Mr. Lugger.

This species is one of the giants of the genus and is very distinct in all its characters, but cannot be generically separated, as far as can be judged without dissection.

The individual facets of the eye are large and very much less strongly convex than in any other species which I have examined.

43 **T. incertus** n. sp.—Slightly robust, piceous; elytra rufescent; abdomen black; legs and antennæ flavate; pubescence very fine, short, not dense; integuments shining. *Head* very slightly wider than long, scarcely perceptibly narrower than the prothorax, broadly convex, strongly reticulate or subgranulose, the punctures very minute and not distinct among the reticulations; prominences not very strong, moderate in size; eyes rather large and finely faceted, convex and somewhat prominent, the tempora scarcely one-half as long, rounded and equally prominent; antennæ short, rather slender, somewhat strongly incrassate, about as long as the head and prothorax; outer joints distinctly transverse, two to four rapidly shorter, fourth scarcely wider than long. *Prothorax* one-third wider than long, widest near anterior third, where the sides are rather strongly rounded and coarctate to the apex, feebly convergent and nearly straight toward base; the latter strongly arcuate, four-fifths as wide as the disk and subequal to the apex; the latter very feebly arcuate; apical angles narrowly rounded; disk very obsoletely bi-impressed, the impressions interrupted, finely and obsoletely subreticulate, very minutely, feebly punctate, the punctures separated by three or four times their own widths, except near the sides, where they become abruptly coarse and dense, with the surface dull. *Elytra* slightly shorter than wide, one-third wider and one-half longer than the prothorax, distinctly impressed on the suture toward base, rather finely and sparsely punctate, the punctures four times as wide as those of the prothorax, separated by more than their own diameters. *Abdomen* distinctly narrower than the prothorax, parallel; sides very feebly arcuate; border moderate; surface very obsoletely and somewhat finely reticulate, minutely and sparsely punctate. *Legs* rather slender. Length 1.8 mm.

Tennessee 3. Mr. Otto Lugger.

This species is somewhat intermediate between the two groups IV and V, as shown by the increase in the size of the eye and

shortening of the tempora; the latter, however, still remain as prominent as the eye, and it is therefore a more nearly normal form for the group than the following.

44 **T. delicatus** n. sp.—Slender and somewhat depressed, piceous; elytra paler, rufo-piceous; abdomen black; legs dark brownish-flavate; antennæ piceo-castaneous; pubescence extremely fine, short, and dense; integuments subalutaceous. *Head* very slightly narrower than the prothorax, moderately convex, minutely and very densely punctate; prominences small but strong; eyes large, moderately convex and but slightly prominent, much more than usually finely faceted; tempora short, scarcely more than one-third as long, narrowly rounded and not quite as prominent as the eye; antennæ rather slender, distinctly capitate, as long as the head and prothorax; joints two to four decreasing very rapidly in length, the fourth much wider than long, second more robust, tenth distinctly transverse. *Prothorax* two-fifths wider than long, widest at anterior third, where the sides are evenly and rather strongly rounded and coarctate to the apex, moderately convergent and nearly straight toward base; the latter feebly arcuate, four-fifths as wide as the disk and slightly narrower than the apex; the latter transversely truncate; apical angles slightly obtuse, not distinctly rounded, the basal broadly rounded; disk very finely and extremely densely punctate; median line not at all impunctate, although slightly tumid toward base; surface very feebly bi-impressed, the impressions almost completely interrupted in the middle, so as to form four feeble oval impressions. *Elytra* slightly longer than wide, one-third wider and three-fourths longer than the prothorax, very feebly impressed near the suture toward base, finely and densely punctate. *Abdomen* scarcely at all narrower than the elytra, parallel; sides nearly straight; border wide and very shallow; surface finely reticulate, minutely and very densely punctate. *Legs* normal. Length 1.3 mm.

Michigan (Detroit 1). Mr. E. A. Schwarz.

Quite distinct from any other in this group, except the preceding, in its larger eyes and relatively shorter tempora; in fact, it constitutes an apparent transition from the present group to the following.

Group V.

A large section of this extensive group shows considerable affinity with Bledius in the form of the prothorax, but in scarcely any other way, the species of this section being closely allied and often difficult to identify from descriptions. The group is somewhat heterogeneous, containing several sections which differ considerably from each other in general form and appearance.

The following table will, it is hoped, prove of some service as an aid to identification:—

Body less slender, sometimes quite robust, more convex, the pronotum generally not at all impressed, although sometimes exhibiting very feeble traces of the usual two impressions.

Prothorax widest at or near anterior third, the sides at this point more strongly rounded and evenly coarctate to the apex.

Eyes smaller, but very slightly prominent and not so coarsely faceted, the tempora very slightly visible behind them, broadly rounded and convergent posteriorly, and distinctly less prominent than the eye.............. ....45 pudicus

Eyes very convex, prominent, more coarsely faceted as usual.

Form more robust; prothorax but slightly narrowed toward base, the sides parallel in the apical half and strongly arcuate; legs pale... ....46 **robustulus**

Form more slender; prothorax strongly narrowed toward base, the sides strongly rounded in the anterior third.

Eyes smaller, scarcely longer than the first antennal joint. 47 **confinis**

Eyes much larger and more prominent, very coarsely faceted, distinctly longer than the first antennal joint. 48 **pauperculus**

Prothorax gradually and moderately narrowed from apex to base and broadly, evenly, and rather strongly arcuate; body rather slender and convex.

Pronotum with a distinct median impunctate line extending from the basal margin to the apex, gradually becoming broader throughout its length.................................49 **languidus**

Pronotum without a median impunctate line, the punctures a little more sparsely distributed in the middle near the apex. 50 **bipuncticollis**

Prothorax widest at or near the middle, the sides at this point rather narrowly rounded and very obtuse, thence parallel or feebly convergent and more or less feebly arcuate to the apex, and more distinctly convergent and more nearly straight to the base.

Size larger, not less than 2 mm. in length; pronotal punctures distinctly separable, the interspaces shining; eyes normal for the group and without trace of tempora.

Prothorax large, as wide as the elytra.

Punctuation excessively fine and dense, lustre dull; median impunctate line of pronotum very narrow.

Piceous; sides of prothorax in anterior half parallel. 51 **simplarius**

Castaneous; abdomen piceous; sides distinctly convergent from behind the middle to the apex........52 **pallidulus**

Punctuation coarser and sparser; lustre shining; median impunctate line of pronotum wide and evident..53 **convexulus**

Prothorax distinctly narrower than the elytra; color black, rarely slightly piceous.

Antennæ less robust, much longer than the head and prothorax, the latter relatively much smaller................54 **debilis**

Antennæ robust, never longer than the head and prothorax, the latter relatively larger.

Elytra slightly longer than wide, with two small approximate impressions at the middle of the base; abdomen much narrower than the elytra, slender, linear, with the sides straight....... ....55 **bledinus**

Elytra slightly but distinctly wider than long and but very slightly wider than the abdomen.

Abdominal punctuation fine and very dense, with the surface alutaceous; punctuation and pubescence throughout very dense, the latter conspicuous.

Elytra not at all impressed, rather convex ....56 **fallax**

Elytra distinctly impressed near the suture toward base, 57 **providus**

Abdominal punctuation very minute and much sparser, the surface distinctly shining; pubescence extremely short and fine, and, although sometimes rather dense, never decidedly conspicuous.

Legs pale flavate; prothorax narrowed very slightly behind, the base almost as wide as the apex. 58 **inquisitus**

Legs black or piceous-black, the tarsi and sometimes the knees paler; prothorax strongly narrowed behind, the base being much narrower than the apex.

Prothorax more strongly transverse, about one-fourth wider than long, the surface more finely and densely punctate and decidedly alutaceous, the median impunctate line very fine and slightly tumid. 59 **facetus**

Prothorax more elongate, not more than one-fifth wider than long, more coarsely, sparsely punctate, shining or polished; median impunctate area not tumid.

Punctuation denser, the punctures separated by about their own diameters........60 **confusus**

Punctuation sparser, the punctures separated by about twice their own diameters...61 **scrupulus**

Size smaller, 1.5 mm., slender; lustre dull, the punctures of the pronotum not distinct. ....62 **insolitus**

Size very small; body depressed; eyes smaller and more finely faceted, the tempora slightly visible behind them but not prominent......... ....63 **uniformis**

Body very slender and linear; pronotum with two parallel, approximate and very distinct impressions; body black, elytra more or less pale.

Antennæ shorter, as long as the head and prothorax........64 **filum**

Antennæ longer, more slender, distinctly longer than the head and prothorax; legs pale.

Prothorax nearly one-fourth wider than long, and strongly narrowed toward base; pubescence coarse ...... 65 **decoloratus**

Prothorax about one-fifth wider than long, more feebly narrowed toward base; pubescence shorter and very fine....66 **tantillus**

45 **T. pudicus** n. sp.—Rather robust and convex, black throughout; legs, antennæ and palpi piceous-black, tarsi flavate; pubescence very minute, slender and moderately dense, not conspicuous; body shining, head and prothorax alutaceous. *Head* distinctly narrower than the prothorax, fully as long as wide, rather convex, finely reticulate, minutely and densely punctate; prominences small, not very pronounced; eyes small, moderately convex, not very coarsely faceted, and but slightly prominent; antennæ short, slightly shorter than the head and prothorax, rather slender, very feebly incrassate; joints two to four uniformly and very rapidly decreasing in length, fourth scarcely as long as wide, tenth slightly wider than long. *Prothorax* slightly shorter than the head, one-third wider than long, widest at anterior third, where the sides are rather narrowly, evenly rounded and coarctate to the apex, rather strongly convergent and nearly straight toward base; the latter broadly arcuate, three-fourths as wide as the disk and much narrower than the apex; the latter broadly and very feebly arcuate; apical angles slightly obtuse, but very slightly rounded, basal more broadly so; disk excessively feebly and indistinctly bi-impressed, broadly convex, minutely, densely granulose, very minutely, scarcely perceptibly and moderately densely punctate, without smooth median line; surface scarcely visibly tumid in the middle near the basal margin. *Elytra* slightly wider than long, one-fourth wider and two-fifths longer than the prothorax, very broadly, feebly impressed on the suture near the base, somewhat coarsely, very feebly and densely punctate, shining. *Abdomen* very slightly narrower than the elytra, parallel; sides feebly arcuate; border moderate; surface shining, rather coarsely and feebly reticulate, minutely and not very densely punctate. *Legs* very slender. Length 1.5 mm.

New Jersey (Cape May 6).

This very small species may be distinguished by its rather robust form and somewhat transverse unimpressed prothorax.

The eyes are very small for this genus and are rather strongly dorsal, a portion of the tempora being seen beneath and behind them when viewed vertically. It is therefore one of the intermediate forms in the grouping here adopted, but belongs to the present group rather than to the preceding.

46 **T. robustulus** n. sp.—Moderately robust and convex, piceous-black; elytra rufescent; legs pale brown; antennæ fuscous; pubescence minute and moderately dense; integuments feebly shining. *Head* slightly narrower than the prothorax, feebly convex, minutely, very densely and feebly punctate, and more strongly subgranulose; prominences rather small but strong; eyes moderate, rather convex and slightly prominent; antennæ not very robust, very short, distinctly shorter than the head and prothorax, moderately incrassate; second joint nearly as long as the next two together, third more than twice as long as the fourth, the latter subquadrate, tenth slightly transverse. *Prothorax* one-fifth wider than long, widest at anterior third; sides in the anterior half nearly parallel, broadly, evenly and distinctly arcuate, thence more convergent and more nearly straight to the base, which is nearly three-fourths as wide as the disk and very much narrower than the apex; the latter subtruncate; apical angles slightly obtuse and scarcely at all rounded; disk not impressed, evenly convex, finely and very densely punctate, the punctures not very deep, separated by nearly their own widths; median impunctate area narrow, short and slightly tumid. *Elytra* very slightly wider than long, one-third wider and longer than the prothorax, feebly impressed near the suture at base, rather coarsely and densely punctate; the punctures deep, more than twice as wide as those of the pronotum, separated by distinctly more than their own diameters. *Abdomen* slightly narrower than the elytra, parallel; sides very feebly arcuate; border rather narrow and deep; surface strongly reticulate, minutely and not very densely punctate. *Legs* moderate. Length (strongly contracted) 1.8 mm.

New York 1.

Allied to the *simplarius* group, from which it differs in the form of the prothorax, which is, however, rather an extreme limit than an essential difference of form, such for instance as is exhibited in the two following species.

47 **T. confinis** n. sp.—Rather slender and convex, black; legs piceous, knees, tips of tibiæ and tarsi flavescent; antennæ dark piceous-brown, piceous at apex; pubescence short, rather coarse and dense; integuments distinctly shining. *Head* slightly narrower than the prothorax, fully as long as wide, rather convex, minutely and very densely punctate; prominences rather broad, moderate; eyes moderate, con-

vex, and prominent, very coarsely faceted; antennæ short, somewhat slender, distinctly capitate, not quite as long as the head and prothorax; second joint nearly as long as the next two together, third very slightly longer than wide, fourth small, quadrate, joints two to four gradually decreasing in thickness, tenth very distinctly transverse. *Prothorax* one-fourth wider than long, widest at anterior third, where the sides are rather broadly rounded and coarctate to the apex, rather strongly convergent and straight toward base; the latter broadly arcuate, about three-fourths as wide as the disk and much narrower than the apex; the latter broadly, feebly arcuate; apical angles distinctly rounded, basal rather broadly so; disk broadly convex, without trace of impression but with a rather wide, impunctate median line, which is not at all tumid; punctures minute and very dense. *Elytra* quadrate, about one-third wider and one-half longer than the prothorax, feebly convex, rather distinctly impressed near the suture, somewhat finely and densely punctate; the punctures twice as large as those of the pronotum and separated by less than twice their own diameters. *Abdomen* distinctly narrower than the elytra, parallel; sides nearly straight; border moderate; surface finely, feebly reticulate, minutely and moderately densely punctate. *Legs* slender. Length 2.1 mm.

California (San Diego 1).

This species somewhat resembles *debilis*, and without care might possibly be confounded with it, especially as they are inhabitants of the same region. It is easily distinguishable, however, by its smaller eyes, much shorter antennæ, which are of a different structure, by the form of the prothorax, presence of a median impunctate line, lack of impressions, and by the coarser, sparser elytral punctures. The form of body is more slender.

48 **T. pauperculus** n. sp.—Moderately robust and convex, black; legs rather pale piceous-brown; antennæ rufo-testaceous, fuscous at apex; pubescence very minute, fine, moderately dense; integuments rather shining. *Head* slightly narrower than the prothorax, very minutely and extremely densely punctate; prominences moderate in size, not strong; antennæ rather short, moderately robust, slightly incrassate, slightly shorter than the head and prothorax; joints two to four decreasing very rapidly in length, the former just visibly more robust, three times as long as the latter, which is very slightly wider than long, tenth strongly transverse; eyes very large and prominent, very coarsely faceted. *Prothorax* widest near apical third, where the sides are evenly rounded, thence very feebly convergent and distinctly arcuate to the apex, rather strongly convergent and nearly straight toward base; the latter evenly and distinctly arcuate, three-fourths as wide as the disk and very much narrower than the apex; the latter broadly, feebly

arcuate; apical angles narrowly, basal broadly, rounded; disk nearly one-fourth wider than long, broadly, evenly convex, without impressions but with a feebly tumid, impunctate and rather broad line, extending from near the base slightly beyond the middle, remainder minutely, very densely punctate. *Elytra* quadrate, one-third wider and one-half longer than the prothorax, rather convex, feebly impressed near the suture toward base, rather finely and densely punctate; the punctures nearly three times as large and twice as distant as those of the pronotum. *Abdomen* distinctly narrower than the elytra, parallel; sides very feebly arcuate; border moderate, shallow; surface shining, finely reticulate, minutely and rather densely punctate. *Legs* slender. Length 2.0 mm.

California (Fort Yuma 1).

This species is of a rather uncommon type in this part of the genus, and may be distinguished by the form of the prothorax and its very large, prominent eyes. It is somewhat allied to *confinis*.

The two following species are more slender, parallel, and convex, with the pronotum perfectly devoid of any trace of impression.

49 **T. languidus** n. sp.—Slender, linear, moderately convex, piceous-black; legs rather dark brown; antennæ piceous throughout; pubescence minute, moderately dense; integuments rather shining. *Head* very slightly narrower than the prothorax, feebly convex, minutely, very densely punctate and subgranulose; prominences rather large and strong; eyes moderate, convex, and slightly prominent; antennæ slightly robust, very short, moderately incrassate, much shorter than the head and prothorax, outer joints rather strongly transverse; joints two to four decreasing very rapidly in length, the latter scarcely as long as wide. *Prothorax* one-fifth wider than long; sides convergent from apex to base, broadly and nearly evenly arcuate; base feebly arcuate, about four-fifths as wide as the apex; the latter very feebly arcuate; apical angles slightly obtuse and rounded; disk not impressed, evenly convex, finely, densely punctate; the punctures slightly sparser near the middle, where they are separated by slightly more than their own widths, and where there is a rather wide, slightly tumid, impunctate line, extending from the base to the apex, becoming wider anteriorly; two setigerous punctures feeble. *Elytra* quadrate, very slightly wider and nearly one-third longer than the prothorax, distinctly impressed near the suture toward base, somewhat finely, not very densely and rather feebly punctate. *Abdomen* very slightly narrower than the elytra, moderate in length, parallel; sides nearly straight; border mode-

rate, shallow; surface finely and moderately reticulate, minutely and not very densely punctate. *Legs* slender, normal. Length 1.9 mm.

Texas (Waco 1).

Easily distinguishable from *bipuncticollis*, to which it is allied, by its larger size, slightly more robust form, more robust antennæ, sparser pronotal punctuation, and by the presence of a long, wide, and slightly tumid, median impunctate line.

50 **T. bipuncticollis** n. sp.—Very slender, rather convex, piceous-black; legs pale brown; antennæ fuscous; pubescence extremely short, fine, moderately dense, sparse on the elytra; integuments distinctly shining. *Head* very slightly narrower than the prothorax, rather convex, very minutely, densely punctate and subgranulose; prominences small and feeble; eyes moderate, somewhat convex and slightly prominent; antennæ very short and slender, feebly incrassate, much shorter than the head and prothorax; second joint fully as long as the next two together, and decidedly more robust, fourth scarcely as long as wide, tenth rather strongly transverse. *Prothorax* one-sixth wider than long; sides convergent from apex to base, rather strongly and nearly evenly arcuate; base feebly arcuate, nearly four-fifths as wide as the apex, which is broadly, feebly arcuate; apical angles not distinctly rounded, basal rather broadly so; disk evenly convex, not impressed, very minutely and densely punctate; the punctures separated by about their own widths, sparse in the median line toward apex, but not toward base; median line not tumid. *Elytra* quadrate, very slightly wider and nearly one-third longer than the prothorax, strongly impressed near the suture except near the apex, rather finely and not very densely punctate; punctures more than twice as wide as those of the pronotum, separated by distinctly more than their own widths. *Abdomen* long, linear, slightly narrower than the elytra; sides straight; border rather narrow; surface finely reticulate, minutely and not very densely punctate. *Legs* slender; femora, especially the anterior, compressed. Length 1.6 mm.

Texas (Waco 2).

Just behind the middle of the pronotum there are two small feeble impressed punctures, arranged transversely and separated by between one-fifth and one-sixth the total width. These punctures are setigerous and may be peculiar to a large part of the genus, at least they are easily observable in some of the species of this group, and notably in *languidus*, *facetus*, and *robustulus*.

We arrive here at a minor group in which the species are

more than usually interallied; they are easily distinguishable in common by the form of the prothorax, its general freedom from any distinct impressions, and by the slightly more robust and convex form. These species generally resemble the genus Bledius, and often display a decidedly close affinity with it, merely, however, in external form, for all the generic characters are perfectly Trogophlœoid. The resemblances are, therefore, probably as likely to have resulted from mimicry or similarity of physical conditions of life, as from any other circumstance.

51 **T. simplarius** Lec.—Trans. Am. Ent. Soc., VI., p. 244.

The original description appears to coincide with the type, except the phrase "Prothorax . . . without dorsal line." There is a very fine but distinct median impunctate line as in *pallidulus.*

52 **T. pallidulus** n. sp.—Rather robust, moderately convex, pale castaneous; abdomen darker, nearly piceous; legs pale flavate; antennæ pale rufous; pubescence very fine, short and dense; integuments alutaceous. *Head* nearly five-sixths as wide as the prothorax, feebly convex, excessively minutely and densely punctate; prominences very large and strong; eyes large, very coarsely faceted, rather prominent; antennæ short and rather robust, shorter than the head and prothorax, outer joints slightly transverse; basal joint as long as the next two together, second very slender, as long as the next two together, fourth scarcely longer than wide. *Prothorax* large, two-fifths wider than long, widest slightly behind the middle, where the sides are obtusely subangulate, the angle slightly rounded, thence just visibly convergent and feebly arcuate to the apex, more strongly convergent and straight toward base; the latter subtruncate between the very broadly rounded basal angles, nearly four-fifths as wide as the disk; apex distinctly wider than the base, broadly, feebly arcuate; apical angles nearly right, very narrowly rounded; disk broadly, evenly convex, without trace of impression, with a very narrow, smooth, impunctate median line, minutely, evenly and extremely densely punctate. *Elytra* about equal in width to the prothorax and one-third longer, slightly shorter than wide, broadly, feebly impressed on the suture at base, finely, very densely punctate; punctures separated by their own widths; inner apical angles narrowly rounded. *Abdomen* very slightly narrower than the elytra; sides parallel, nearly straight; border relatively narrow, moderately deep; segments scarcely perceptibly impressed at base; surface feebly convex, very minutely and densely punctate. *Legs* slender. Length 2.9 mm.

Lake Superior[1] 1.

A rather robust species, easily to be identified by its large prothorax, pale colors, and very dense punctuation; it is very distinct in all its characters.

53 **T. convexulus** Lec.—Trans. Am. Ent. Soc., VI., p. 244.

The original type greatly resembles *scrupulus*, but differs in its much longer and wider prothorax; the surface is shining and polished. It is the only known representative.

54 **T. debilis** n. sp.—Rather slender and convex, black; legs piceous, knees, tips of the tibiæ and tarsi flavescent; antennæ, mandibles and palpi piceous; pubescence short, fine and dense, rather conspicuous, cinereous; integuments feebly shining. *Head* slightly narrower than the prothorax, as long as wide, moderately convex, very finely and extremely densely punctate; prominences narrow and strong; eyes large, prominent, coarsely faceted; antennæ rather slender, distinctly longer than the head and prothorax, extremely feebly incrassate; second joint subcylindrical, slightly more than twice as long as wide, third obconical, as wide at apex as the second and three-fourths as long, fourth very slightly shorter than the third and more robust than the second, distinctly longer than wide, tenth very slightly wider than long. *Prothorax* scarcely one-fourth wider than long, widest just before the middle, where the sides are obtusely rounded, thence very feebly convergent and distinctly, evenly arcuate to the apex, more strongly convergent and feebly sinuate to the base, which is broadly arcuate, four-fifths as wide as the disk and very slightly narrower than the apex; the latter transversely subtruncate; apical angles slightly obtuse and narrowly rounded, basal more obtuse and broadly rounded; disk broadly convex, very obsoletely, longitudinally bi-impressed, the impressions subinterrupted, without trace of median impunctate line, finely and very densely punctate. *Elytra* fully as long as wide, nearly one-half wider and longer than the prothorax, feebly impressed near the suture, very minutely and densely punctate; punctures equal to those of the pronotum but about twice as distant. *Abdomen* very distinctly narrower than the elytra, parallel; sides nearly straight; border rather strong and shallow; surface finely reticulate, minutely and densely punctate. *Legs* slender. Length 2.5 mm.

[1] I am not absolutely sure that the locality here given is correct. See remarks under description of *Lathrobium inops* (Cont. Col. N. A., II., p. 186).

The same remark applies to the locality here assigned to *fallax*.

California (San Diego 11).

This species is quite abundant on the banks of wet ditches near the town. It is very distinct in its longer antennæ and relatively smaller prothorax.

55 **T. bledlinus** Lec.—Trans. Am. Ent. Soc., VI. p. 241. -Rather slender, moderately convex, black; legs piceous, knees, tips of tibiæ and tarsi pale; antennæ piceous; pubescence extremely short, rather dense but not very conspicuous; integuments slightly shining. *Head* slightly narrower than the prothorax, scarcely as long as wide, very minutely and densely punctate; prominences rather large and strong; eyes moderate, very convex, prominent, very coarsely faceted; antennæ rather slender, short, not as long as the head and prothorax, very feebly incrassate; second joint as long as the next two together and rather more robust, third one-half longer than the fourth, the latter slightly wider than long, tenth rather strongly transverse. *Prothorax* about one-fifth wider than long; sides in the apical half almost parallel, evenly and feebly arcuate, moderately convergent and feebly sinuate in the basal half; base broadly arcuate, fully four-fifths as wide as the disk; apex transversely, very feebly arcuate; apical angles nearly right, narrowly rounded, basal broadly rounded; disk broadly, evenly convex, not impressed but with a rather wide, impunctate, median line, which appears to be sometimes slightly tumid; punctures minute and dense. *Elytra* slightly longer than wide, scarcely one-third wider and fully three-fifths longer than the prothorax, rather distinctly impressed near the suture at the base, finely, rather densely punctate; punctures rather coarser than those of the pronotum and about twice as distant. *Abdomen* very distinctly narrower than the prothorax; sides nearly parallel, straight; surface finely reticulate, minutely and densely punctate, rather shining. *Legs* very short, slender. Length 2.2 mm.

California (San Diego 2).

A small slender species, somewhat resembling *confinis*, but differing in its longer elytra and in the shape of the prothorax.

56 **T. fallax** n. sp.—Somewhat slender, convex, piceous-black; legs brownish-flavate; antennæ fuscous, piceous toward apex; pubescence short, subrecumbent, very dense and rather conspicuous, especially on the anterior portions; integuments rather dull. *Head* slightly narrower than the prothorax, feebly convex, minutely, densely punctate and subgranulose; prominences rather large, slightly elongate and strong; eyes large, strongly convex and prominent, very coarsely faceted; antennæ short and rather robust, much shorter than the head and prothorax; joints two to four decreasing very rapidly in length,

the latter distinctly wider than long and one-third as long as the second, tenth distinctly wider than long. *Prothorax* widest just before the middle, where the sides are distinctly rounded and obtusely subangulate, thence very feebly convergent and feebly arcuate to the apex, more strongly convergent and nearly straight toward base; the latter broadly arcuate, nearly three-fourths as wide as the disk, very much narrower than the apex; the latter very feebly arcuate; apical angles slightly obtuse and not distinctly rounded; disk one-fifth wider than long, evenly convex, not at all impressed, minutely and excessively densely punctate; punctures almost in mutual contact, the median impunctate line short, very narrow, not tumid and very inconspicuous. *Elytra* subquadrate, rather evenly convex and not at all impressed near the suture, about one-fifth wider and one-third longer than the prothorax, finely, very feebly and densely punctate. *Abdomen* slightly narrower than the elytra, parallel; sides nearly straight; border moderate, somewhat deep; surface finely and strongly reticulate, minutely and very densely punctate. *Legs* normal. Length 2.4 mm.

Lake Superior 1.

As must be evident from the description, this very distinct species differs from all the others of the *pallidulus* group by the longer, coarser, and denser pubescence, and correspondingly denser punctuation, in this respect being allied only to *providus*. The elytra, also, differ in not being distinctly impressed near the suture.

57 **T. providus** n. sp.—Moderately slender, rather convex, black; legs piceous; antennæ piceous, fuscous at base; pubescence cinereous, very short, fine and dense, rather conspicuous; integuments alutaceous, elytra a little more shining. *Head* slightly narrower than the prothorax, feebly convex, very finely and extremely densely punctate; prominences rather large and strong; eyes large, convex, prominent, very coarsely faceted; antennæ scarcely as long as the head and prothorax, not very robust, moderately incrassate; joints two to four uniformly and rather rapidly decreasing in length, the second slightly more robust; fourth one-half longer than wide, tenth slightly wider than long. *Prothorax* about one-fourth wider than long, widest at the middle; sides very feebly convergent and distinctly arcuate to the apex, more strongly convergent and nearly straight toward base; the latter broadly arcuate, four-fifths as wide as the disk and very slightly narrower than the apex; the latter truncate ; apical angles nearly right, very narrowly rounded; disk broadly, nearly evenly convex, with two approximate, extremely feeble impressions near the basal margin in the middle; surface very finely and excessively densely punctate, without trace of a median im-

punctate line. *Elytra* subquadrate, two-fifths wider and nearly one-half longer than the prothorax, feebly impressed near the suture toward base; disk rather convex, very finely, densely punctate; punctures separated by fully their own widths, with the interspaces polished. *Abdomen* slightly narrower than the elytra, parallel; sides feebly arcuate; border rather thick and shallow; surface very minutely, densely punctate. *Legs* slender. Length 2.1 mm.

New Jersey (Cape May; Atlantic City 2).

Distinguished by its very fine, dense punctures and very dense, cinereous pubescence.

58 **T. inquisitus** n. sp.—Moderately robust, feebly convex, the elytra somewhat depressed, piceous; legs and antennæ flavate, pubescence very fine, short, not very dense; integuments feebly shining. *Head* slightly narrower than the prothorax, very feebly convex, minutely and extremely densely punctate; prominences moderate, rather strong; antennæ short, rather slender, shorter than the head and prothorax, very feebly incrassate; joints two to four very rapidly decreasing in length, the former slender, as long as the next two together, and more than three times as long as the fourth, which is slightly wider than long, tenth decidedly transverse; eyes rather large, convex, and prominent, very coarsely faceted. *Prothorax* one-fifth wider than long, widest in the middle, where the sides are rounded and very obtusely subangulate, thence excessively feebly convergent, almost parallel and feebly arcuate to the apex, and rather feebly convergent and nearly straight to the base, which is broadly arcuate, nearly five-sixths as wide as the disk and but slightly narrower than the apex; the latter transversely subtruncate; apical angles very narrowly rounded, basal more broadly so; disk broadly, evenly convex, not impressed, minutely, very densely punctate, with a narrow, feeble, impunctate median line from before the middle nearly to the base, which is not at all tumid. *Elytra* very slightly wider than long, slightly more than one-fourth wider and about one-third longer than the prothorax, rather broadly conjointly impressed along the suture, finely, densely punctate; punctures slightly larger than those of the pronotum and separated by fully twice their own diameters. *Abdomen* parallel, distinctly narrower than the elytra sides very feebly arcuate; border moderate but rather deep; surface coarsely and rather strongly reticulate, minutely and somewhat densely punctate. *Legs* slightly robust. Length 2.0 mm.

Texas (Galveston 1).

May be known from its allies which follow by its pale legs and antennæ, finer elytral punctuation, and shape of the prothorax, which is unusually wide at base.

59 **T. facetus** n. sp.—Moderately slender, rather convex, black; legs piceous, the knees, tips of tibiæ, and tarsi rufo-flavescent; antennæ piceous throughout; pubescence excessively fine, minute, dense although inconspicuous, much sparser on the elytra and abdomen; head and pronotum alutaceous, remainder shining. *Head* distinctly narrower than the prothorax, minutely and excessively densely punctate; prominences rather large, although but moderately strong; antennæ short, rather slender, and extremely feebly incrassate, slightly shorter than the head and prothorax; joints two to four decreasing very rapidly in length, the second scarcely more robust and slightly more than twice as long as the fourth, which is obconical and slightly longer than wide, tenth slightly transverse; eyes moderate, rather convex, and somewhat prominent. *Prothorax* about one-fourth wider than long, widest just before the middle, where the sides are broadly rounded and very obtusely subangulate, thence very feebly convergent and broadly arcuate to the apex, more strongly convergent and nearly straight to the base, which is but slightly over two-thirds as wide as the disk and four-fifths as wide as the apex; the latter broadly, very feebly arcuate; apical angles very narrowly, basal more broadly, rounded; disk broadly, evenly convex, not impressed, but with a rather narrow, slightly tumid, impunctate line, from before the middle nearly to the base, very minutely and densely punctate. *Elytra* very slightly shorter than wide, slightly wider near the apex than at base, about one-third wider and longer than the prothorax, rather strongly impressed near the suture toward base, somewhat coarsely, deeply, and densely punctate; punctures three or four times as large as those of the pronotum and separated by from once to twice their own diameters. *Abdomen* distinctly narrower than the elytra and wider than the prothorax, parallel; sides feebly arcuate; border moderate; surface finely and very feebly reticulate, minutely and not very densely punctate. *Legs* slender. Length 2.2 mm.

Rhode Island (Newport 10).

Easily distinguishable by its alutaceous head and prothorax, and relatively coarsely punctate elytra.

60 **T. confusus** n. sp.—Slender, black; antennæ throughout and legs piceous-black; tarsi flavescent; pubescence very short, moderately dense, and somewhat coarse; integuments somewhat shining. *Head* slightly narrower than the prothorax, feebly convex, very finely and densely punctate; prominences short, moderate; antennæ slightly shorter than the head and prothorax, moderately robust, distinctly incrassate, outer joints rather transverse; second joint nearly as long as the next two together, fourth fully as wide as long and scarcely more than one-half as long as the third; eyes rather small, convex, rather prominent, coarsely faceted. *Prothorax* widest just before the middle,

where it is scarcely more than one-seventh wider than long; sides obtusely angulate and rounded, feebly convergent and feebly arcuate to the apex, slightly more strongly convergent and nearly straight toward base; the latter feebly arcuate, scarcely three-fourths as wide as the disk, very much narrower than the apex; the latter feebly arcuate; basal angles rather more narrowly rounded than usual, apical obtuse, slightly rounded; disk evenly convex, not impressed, finely, deeply, and densely punctate, the median impunctate area very narrow, short, and not at all well defined, not tumid. *Elytra* very nearly as long as wide, nearly one-third wider and about one-fourth longer than the prothorax, rather convex, very feebly impressed near the suture toward base, moderately, rather deeply and densely punctate; punctures separated by but slightly more than their own diameters. *Abdomen* slightly narrower than the elytra, parallel; sides slightly arcuate; border moderate; surface finely, feebly reticulate, minutely and rather densely punctate. *Legs* slender. Length 1.9 mm.

New Jersey (Cape May 1).

The three species, *facetus, scrupulus,* and *confusus,* are mutually rather closely allied, and although at once distinguishable when compared, are not so easily differentiated by description. It may be stated, however, that the prothorax of *facetus* is distinctly transverse, excessively densely punctate, alutaceous, and with a very narrow slightly tumid median impunctate area. In *scrupulus* the prothorax is not as transverse as in *facetus,* and its surface is polished and more than twice as sparsely punctate, the punctures feebler, and the median area twice as wide and not at all tumid. In *confusus* the prothorax is but just visibly wider than long, and is nearly as densely and deeply punctate as in *facetus,* but not alutaceous; the median area is rather wider than in that species, not tumid, and not very well defined; the eyes and elytra also are relatively smaller than in either of the others. In *scrupulus* the elytra are more sparsely punctate.

61 **T. scrupulus** n. sp.—Moderately slender, rather convex, black; legs piceous-black, tarsi paler; antennæ black throughout; pubescence extremely fine, short, rather sparse, and scarcely noticeable; integuments shining. *Head* rather small, scarcely four-fifths as wide as the prothorax, feebly convex, finely and strongly granulose and subalutaceous, the punctures so nearly obsolete as to be not distinctly definable amongst the granules; prominences small, but rather strong; antennæ short and robust, scarcely as long as the head and prothorax, strongly

incrassate, outer joints distinctly transverse; joints two to four decreasing very rapidly in length, second nearly as long as the next two combined, fourth very slightly longer than wide, feebly obconical; eyes rather large, convex, prominent and coarsely faceted. *Prothorax* widest just before the middle, where the sides are distinctly rounded and obtusely subangulate, thence slightly convergent and evenly, distinctly arcuate to the apex, slightly more strongly convergent and nearly straight toward base; the latter broadly arcuate, fully three-fourths as wide as the disk and much narrower than the apex; the latter feebly arcuate; apical angles slightly obtuse, not distinctly rounded, basal more broadly so; disk about one-fifth wider than long, broadly, evenly convex, not at all impressed, finely and not densely punctate in the middle, the punctures becoming excessively fine and obsolete near the sides, where the surface is more strongly reticulate; median impunctate line rather wide, abbreviated, not sensibly tumid. *Elytra* scarcely perceptibly wider than long, one-fourth wider and one-third longer than the prothorax,feebly impressed near the suture toward base, moderately and sparsely punctate; punctures rather feeble, much larger than those of the pronotum, and separated by fully twice their own diameters. *Abdomen* slightly narrower than the elytra, parallel, shining; border moderate, nearly straight; surface very obsoletely reticulate, minutely and not very densely punctate. *Legs* slender. Length 2.0 mm.

Texas (Galveston 2).

The affinities of this species are stated under the preceding description.

62 **T. insolitus** n. sp.—Slender, slightly convex, black; legs and antennæ piceous; pubescence very short, moderately dense; integuments feebly shining, the head and pronotum dull. *Head* scarcely perceptibly narrower than the prothorax, rather strongly convex, minutely, strongly, and very densely granulose or deeply reticulate, the punctures fine and not distinct; prominences very small, short; eyes moderately prominent, moderately finely faceted; antennæ short, somewhat robust, scarcely as long as the head and prothorax; second joint robust, about as long as the next two together, third distinctly longer than the fourth, slightly longer than wide, the latter wider than long, outer joints strongly transverse. *Prothorax* nearly two-fifths wider than long, widest in the middle; sides thence feebly convergent and very feebly arcuate to the apex, moderately convergent and nearly straight to the base, which ihs tree-fourths as wide as the disk and much narrower than the apex, the latter transversely truncate; apical angles very slightly obtuse and scarcely perceptibly rounded; disk evenly, feebly convex, minutely, strongly, and very densely granulose, dull; punctures very dense and not distinctly defined; the usual two impressions represented by the very feeblest traces, interrupted in the mid-

dle. *Elytra* quadrate, feebly convex, nearly one-fourth wider and one-half longer than the prothorax, slightly impressed at the suture toward base, rather finely, deeply, and very densely punctate, the punctures separated by from one-fourth to one-half their own diameters. *Abdomen* slightly narrower than the elytra and wider than the prothorax; sides parallel and nearly straight; border moderate, shallow; surface rather more shining than the other portions, finely and feebly reticulate, excessively minutely and not densely punctate. Length 1.5 mm.

California (Hoopa Valley, Humboldt Co. 1).

The dull character of the integuments of the head and pronotum is only equalled in the case of *brachypterus* of the preceding group, to which, however, the present species is in no way allied. In general, even though the lustre may be somewhat dull and alutaceous, the punctures will be found to be easily distinguishable, but in this case the minute obscure punctures and reticulations or granulations are confusedly intermingled in such a way as to give a very indistinct, although at the same time homogeneous sculpture.

63 **T. uniformis** Lec.—Trans. Am. Ent. Soc., VI., p. 244.

This is an aberrant species in the grouping here adopted, as the tempora are slightly visible behind the eyes, the latter being decidedly smaller, less prominent, and rather more finely faceted. The prothorax has the same form to be seen in the preceding species, otherwise it would have been placed next to *pudicus*.

The three species which follow are remarkably different, and constitute a rather isolated group, characterized by the slender, linear, somewhat depressed form and distinctly bi-impressed pronotum. In general outline they resemble several of the very slender forms of Group IV, but may be easily distinguished by their large, very convex, and prominent eyes.

64 **T. filum** n. sp.—Very slender, linear, moderately convex, piceous black; elytra rufo-piceous; legs dark brown, paler toward apex; antennæ fusco-piceous, slightly paler toward base; pubescence short, dense, and rather distinct; integuments moderately shining. *Head* very slightly narrower than the prothorax, feebly convex, minutely and densely punctate; prominences rather small and strong; antennæ slender, feebly incrassate, rather small, not longer than the head and prothorax; second joint as long as the next two together, fourth subglobular, tenth very slightly wider than long; eyes large, convex, prom-

inent. *Prothorax* one-fourth wider than long, widest at anterior third, where the sides are evenly rounded and coarctate to the apex, moderately convergent, and straight thence to the base; the latter feebly arcuate, four-fifths as wide as the disk, and very slightly narrower than the apex; the latter feebly arcuate; apical angles obtuse and rather broadly rounded; disk with two very distinct longitudinal arcuate impressions in the basal half, minutely and densely punctate, without trace of median impunctate line. *Elytra* fully as long as wide, one-fourth wider and nearly two-thirds longer than the prothorax, distinctly impressed near the suture, except near the apex, finely and densely punctate; punctures feeble, twice as wide as those of the pronotum, and separated by about their own diameters. *Abdomen* parallel, long, linear, slightly narrower than the elytra; sides straight; border moderate; surface rather strongly convex, finely, feebly reticulate, minutely and densely punctate. *Legs* slender. Length 2.2 mm.

California (Fort Yuma 3).

Easily distinguishable by its elongate, slender form, large eyes, distinctly bi-impressed pronotum and many other characters.

65 **T. decoloratus** n. sp.—Slender, rather feebly convex, black; elytra pale, rufescent, shaded with darker castaneous toward base and suture; legs and antennæ flavate, the latter fuscous near the apex; pubescence short and dense; integuments feebly shining. *Head* distinctly narrower than the prothorax, feebly convex, minutely and very densely punctate; punctures distinct; prominences large and strong; eyes large, convex, and prominent; antennæ rather slender, distinctly incrassate, distinctly longer than the head and prothorax; joints two to four, decreasing uniformly and moderately in length, fourth just visibly longer than wide, tenth almost as long as wide. *Prothorax* widest at anterior third, where the sides are evenly rounded and coarctate to the apex, moderately convergent, and very feebly arcuate toward base; the latter three-fourths as wide as the disk, and slightly narrower than the apex, which is very feebly arcuate; apical angles obtuse and distinctly rounded; disk fully one-fourth wider than long, very broadly, rather feebly though distinctly, longitudinally bi-impressed, minutely and densely punctate, without median impunctate area. *Elytra* fully as long as wide, one-third wider, and nearly three-fifths longer than the prothorax, feebly impressed near the suture, finely, feebly, and densely punctate; punctures scarcely larger than those of the pronotum, but nearly twice as distant. *Abdomen* .distinctly narrower than the elytra, parallel; sides straight; border moderate and rather shallow; surface finely and rather strongly reticulate, minutely and densely punctate. *Legs* slender. Length 2.0 mm.

Pennsylvania (Allegheny Co. 3). Dr. Hamilton.

The impressions of the pronotum are long, closely approximate and nearly straight. In *tantillus* and *filum* they are strongly, inwardly arcuate, and, in the latter very much deeper.

66 **T. tantillus** n. sp.—Very slender, linear, slightly convex, black; elytra pale, rufescent; legs pale, flavate; antennæ pale brown, flavate at base; pubescence fine, rather short, and very dense; integuments feebly shining. *Head* very slightly narrower than the prothorax, feebly convex, minutely, feebly, and very densely punctate; prominences small but strong, separated by one-half the total width; eyes large, convex, prominent; antennæ slender, feebly incrassate, very distinctly longer than the head and prothorax; joints two to four decreasing moderately in length, the fourth scarcely longer than wide, tenth nearly as long as wide. *Prothorax* widest at anterior third, where the sides are rather broadly, evenly arcuate and coarctate to the apex, rather feebly convergent, and very slightly arcuate to the base, which is feebly arcuate, four-fifths as wide as the disk, and very slightly narrower than the apex; the latter very feebly arcuate; apical angles obtuse and scarcely at all rounded; disk feebly convex, one-fifth wider than long, very minutely, densely punctate, with two longitudinal arcuate and moderately feeble approximate impressions, without median impunctate line. *Elytra* as long as wide, one-fourth wider and two-fifths longer than the prothorax, feebly impressed near the suture toward base, minutely and rather densely punctate; punctures not larger, although slightly more distinct than those of the pronotum. *Abdomen* rather distinctly narrower than the elytra, parallel; sides nearly straight; border moderate, shallow; surface finely, feebly reticulate, minutely and densely punctate. *Legs* slender; femora compressed and slightly arcuate. Length 1.8 mm.

Texas (Austin 4).

A small linear species which is very distinct. The coarse tactile setæ, one just over the eye anteriorly, another just behind, over and more distant from the eye, one at the apical angle of the prothorax, and another at the lateral edge at posterior third, are more than ordinarily developed. On the other hand the two discal setæ, mentioned under the description of *bipuncticollis*, do not seem to exist at all. In the latter all the lateral setæ here mentioned exist, as usual, but are very much less developed than in *tantillus*, the habits of life, perhaps, tending rather to the development of the two dorsal setæ.

XVI.—*A New Genus of Termitophilous Staphylinidæ.*

BY THOS. L. CASEY.

Read February 11th, 1889.

The careful and enthusiastic studies of Mr. J. Beaumont, Superintendent of Motive Power of the Panama Railroad, upon the habits of the Termites of the Isthmus of Panama, have already been made known to the Academy through Mr. P. H. Dudley.

During the progress of these investigations, Mr. Beaumont had the good fortune to discover a very remarkable Staphylinide, living in the nests of a species of Termes or allied genus, which latter is at present in the hands of Dr. H. A. Hagen, of Cambridge, Mass., for identification and description.

Through the kindness of Mr. Dudley, I am enabled to present the following diagnosis of this interesting addition to our Termitophilous fauna.

TERMITOGASTER n. gen. (Aleocharini.)

Head moderate in size, very slightly narrowed behind the eyes; sides arcuate; neck wide. *Eyes* well developed, moderately convex, but slightly prominent, finely faceted, rounded, subtruncate anteriorly, more pointed behind; facets not convex. *Antennæ* slender, anteriorly and flexibly geniculate, inserted in rounded apertures on the upper surface of the front, almost adjoining the antero-superior margin of the eye, almost equal in diameter from base to apex; all the joints loosely articulated and subcylindrical; basal joint elongate, almost as long as the next three together; second distinctly longer than wide, a little shorter than the third, and longer than the fourth; five to ten slightly shorter, decreasing gradually in length, the latter about as long as wide; eleventh as long as the two preceding together, conoidal and obtusely pointed at apex. *Front* transversely truncate, short. *Labrum* transverse, moderately strongly and broadly sinuate at apex, the apical portions membranous and transversely foveate in the middle. *Mentum* and submentum in a single piece without trace of suture, nearly flat, thin, coriaceous, smooth and polished, large, broadly rounded at base,

more narrowly so at the sides of the dilated basal portion, the sides and base coarctate, and without basal angles, narrowed anteriorly, the sides becoming broadly sinuate; apex truncate, angles right and scarcely rounded; apical edge with two widely-separated setæ. *Ligula* short and broad, prolonged between the widely-separated palpi in a thick membranous mass; palpi small, three-jointed; third joint slender and subulate; basal joint more robust than the second. *Maxillæ* very large, exserted and slightly visible from above; lobes small, robust, densely ciliate; palpi very irregular, four-jointed; basal joint minute; second large, strongly transverse, acutely ellipsoidal anteriorly, obliquely truncate posteriorly, the truncate surface large, flat, and membranous; third one-half longer than wide, not one-half as wide as the second, slightly narrowed toward apex, which is truncate; fourth oblique, slender, and subulate. *Mandibles* slender, feebly arcuate, not extending beyond the exserted membranous mass of the ligula, acute; the right with a small acute tooth near the apex. Basal plate of maxillæ prolonged outwardly in a short, slender spine which is distinctly visible from above.

Prothorax well developed, subquadrate. Pronotal hypomera narrow, not very strongly inflexed, deeply emarginate almost to the lateral edge anteriorly by the coxal cavities; the latter very large, approaching very near the lateral edges and the apical margin, completely and widely coalescent; the coxæ completely surrounded by white membrane. *Prosternum* very short, the median portion twice as wide as long, slightly tumid, truncate behind, and not entering the intercoxal space. *Coxæ* rather large, compressed, feebly convex anteriorly, and with the exterior edge rather acute.

Mesothorax short. *Scutellum* distinct. *Mesosternal* side-pieces ample, diagonally divided, the suture straight and tangent to the elytral humeri at base. *Intermediate* coxæ distinctly separated, slightly shorter than the anterior, moderate in size.

Metathorax moderate, slightly exposed at the sides by the elytra; the latter much shorter than the pronotum, apparently connate. *Metasternum* not impressed, convex, the episterna narrow and linear; epimera not visible. *Posterior* coxæ horizontal, conical, moderate, very narrowly separated.

Abdomen very strongly dilated, in great part membranous; the dorsal plates entirely surrounded by white membrane, those forming the feebly reflexed margins narrowly separated from the dorsal surfaces of the segments; sides consisting of tumid white membrane, with a slender, oblique setose line of chitinous material at the side of each segment.

Legs slender, moderate in length, coarsely setose. *Tibiæ* without trace of terminal spurs. *Tarsi* cylindrical, moderate in length, sparsely setose, compressed throughout, five-jointed on all the legs, the fourth joint anchylosed with the fifth, but distinctly visible; basal joint as long as the two following, and, in the posterior, as long as the entire

remainder; fourth and fifth together short, in the posterior as long as the second. *Claws* small, slender, strongly arcuate, with a small, vertical, obtusely pointed tooth near the base.

The five-jointed tarsi would seem to point to a relationship with the Alcocharæ, but the maxillary palpi and abdomen isolate it widely from every type of that group which I have been able to examine. The large, white abdomen is probably very extensible, and while moving amongst the Termites, the insect must be difficult to distinguish from them without close examination; in fact we have here a very interesting case of mimicry.

The articulations are all composed of this delicate and very extensible white membrane, so that in the dried state the specimen is extremely fragile.

The genera Corotoca and Spirachtha of Schiödte also have the widely distended semi-membranous abdomen here described, and the former seems to possess some characters in common with Termitogaster, the principal points of resemblance apparently lying in the antennal and tarsal structure; Spirachtha, however, is widely different in nearly all its characters and need not concern us at present.

The basal joint of the tarsi in both Corotoca and Termitogaster is very much more elongate than the others. In the latter the fourth joint is short and rigidly anchylosed with the fifth, although the suture and the emarginations above and beneath are very strongly marked, and could not possibly escape observation if examined, and, as Schiödte ascribes but four joints to the tarsi of Corotoca, either this fact must have been overlooked or the tarsi are really different in structure in spite of their similarity in general form.

The divergencies of structure are, however, fully as marked as the resemblances. The maxillary palpi of Corotoca are very different in form, the first joint being minute, the second clavate, the third subglobose, and the fourth small and cylindrical, with the apex obtuse; the eyes, also, are very large and reniform, and the mandibles edentate.

T. insolens n. sp.—Anterior portions slender; abdomen very strongly inflated; piceous-brown, pronotum black, under surface, legs and chitinous portions of abdomen pale brown, membranous portions pure white. *Head* much shorter and narrower than the prothorax; front tumid

between the bases of the antennæ; surface throughout shining, almost glabrous and impunctate; antennæ about as long as the head, prothorax and elytra combined. *Prothorax* slightly wider than long; base and apex subequal, subtruncate; sides nearly parallel, broadly, feebly arcuate, sinuate at apical two-fifths when viewed laterally; surface moderately convex, shining, excessively finely and feebly subreticulate, and covered sparsely with extremely short fine setæ, having three feeble impressions arranged transversely near the middle of the disk, the lateral prolonged slightly behind; surface also feebly impressed toward the middle in front of the basal margin; disk with a few coarse erect setæ. Scutellum large, prominent, elevated above the elytra, rough, finely setose. *Elytra* connate, slightly narrower than the prothorax; sides nearly straight, very slightly divergent from base to apex; the latter broadly, roundly emarginate throughout the width; disk three-fourths as long the prothorax, flat, polished, glabrous, impunctate, convex at the sides, slightly setose and rough on the basal slope, also roughened on the vertical flanks which are not beaded beneath. *Abdomen* nearly three times as wide as the elytra, widest in the middle; sides strongly arcuate; chitinous surfaces coarsely reticulate, shining, sparsely and coarsely setose. Under surface sparsely setose. Length 2.7 mm. (contracted).

Colombia (Panama 1).

The abdomen consists of the normal number of segments—six, besides the small terminal segment. The labrum is separated from the anterior margin of the front by a short bond of membrane.

The sexual characters cannot be determined from the single specimen above described, which is probably a female. There are four specimens known, one of which is in the Museum of Comparative Zoölogy at Cambridge, Mass., and two still in the possession of Mr. Dudley.

XVII.—The Calceocrinidæ: A Revision of the Family, with Descriptions of some New Species.

BY EUGENE N. S. RINGUEBERG, M.D.

The confusion existing in regard to the nomenclature of the species included in this family, as well as to the proper terminology of the component parts of the calyx and arms, makes a complete revision imperative.

The bibliography on the subject will not be reviewed here, since that has already been done by Messrs. Wachsmuth and Springer in their "Revision of the Palæocrinoidea"; to which those wishing to examine it can refer.

The first attempt to meet the evident necessity for a separation of the family into more than one genus was made by Mr. E. O. Ulrich, who, in 1886, revised the family, calling it *Cremacrinidæ*, in place of *Calceocrinidæ* already proposed by Meek and Worthen, and then proceeded to divide it into three new groups or genera;—*Cremacrinus, Halysiocrinus* and *Deltacrinus,*—totally rejecting the generally accepted genus *Calceocrinus* Hall, except as a sort of convenient receptacle into which could be thrown all such species as would not readily fall under one or the other of his new genera.

While acknowledging the fact that the differences exhibited by the various species called for further generic separation, it must be conceded, with Wachsmuth and Springer, that the setting aside of the family Calceocrinidæ and genus *Calceocrinus* was unwarranted.

A division of the family into several genera is essential for a proper classification of the species contained in it; and our first step must be, in deference to the general acceptance of the term *Calceocrinus,* to decide to what type of calceocrinoid structure Hall's *original* species belongs, before any further divisions are made or others recognized.

It has been thought preferable to do this under the head of *Calceocrinus,* in its proper position in the family, instead of

discussing that point here,—so as to prevent a repetition when that species comes to be described and considered.

CALCEOCRINIDÆ Meek and Worthen.

(Revised by Ringueberg.)

Calyx and arms drooping, being bent into an inverted position, and hanging downward alongside or against the column; parallel with it or diverging at a slight angle from it. Posterior side proximal to the column. Column round, straight, or slightly curved towards the calyx at its upper end, which is attached to the posterior side of the calyx.

Arms three or more, always one anterior and two lateral, and in some they are present on the posterior side. Ventral tube large.

Calyx flattened anteriorly with a truncate base; lateral sides parallel or nearly so, anterior and posterior sides divergent from the truncate base. Posterior side more or less rounded.

Basal plates consolidated into a semicircular or subtriangular piece, which is placed entirely upon the posterior side of the calyx and has its straight side, which is nearly or quite as wide as the base of the calyx, articulating with the truncate base-line of the anterior side by means of a hinge-like joint, while its posterior rounded or truncate pyramidal side fits loosely into an arch, having a similar outline, on that side of the calyx.

The basal piece is somewhat scoop-shaped, having the column inserted at or near the posterior rounded margin, and directed more or less outward from it, forming the handle of the scoop;—the posterior margin, which is incurved, representing the back, and the straight anterior margin the edge.

The anterior margin of this piece, and the adjoining radial articulate margin, are both furnished with grooves extending along the entire margin, or have external semicircular depressions which extend halfway through the plates from the outer side of the margin. These depressions, when present, are most prominent on the anterior or radial side of the articulation, and may be absent on the posterior or basal side, their place being taken by slight sinuosities of the outer non-articular side of the margin.

The grooves and depressions are for the reception of elastic ligaments uniting the two sides.

Externally this articulation has the appearance of a gaping joint or fissure, closed by means of a flexible integument, but internally is actually closed by the exact approximation of the inner edges of the ligament-bearing grooves, and over which the ligaments pass.

The posterior or curved margin was not attached directly to the arch into which it fits, but was united by means of some elastic and flexible medium, which allowed a considerable degree of separation at this point.

This peculiar conformation, the hinge on one side of the piece, and the mobility of the opposite side, allowed the basal piece to swing upon its hinge like a door or lid,—or, more strictly speaking, allowed the radial portion of the calyx to erect itself upon the basal portion. This function was possessed in variable degrees by the different species.

The incurved portion normally lies within the surface of the crinoid when it is at rest, allowing the column, which is inserted into the convexity formed by the curvature, to rest against the arch receiving this portion; and in those species in which the column is straight, or nearly so, and which have the calyx resting against it, the calyx is at times somewhat grooved beyond this point for its reception. Margin of the calyx very irregular, rising into high acute points laterally, with a depression between them on the anterior side and a deeper one on the posterior side.

Calyx composed of two rings of plates, whose number and position vary somewhat in the different genera, due to anchylosis and the modification of some of their functions, but they have the same general disposition in all.

The first or basal ring forms the consolidated basal piece; this is composed of three or four plates, consisting of two anterior basals or their anchylosed equivalent, and two lateral basals. The two lateral basals are the largest, and, taken together, they form the entire posterior margin of the piece extending to the outer angles. The point of attachment for the column is always upon the line of their union, while the apices of the anterior basals may or may not enter into the formation of the columnar facet. These plates together form a somewhat lunate-shaped piece, and are usually not anchylosed.[1]

The anterior basals or their anchylosed equivalent are triangular, and occupy the median portion, or the whole, of the anterior margin. When the two anterior basals are not anchylosed, the dividing suture-line is a continuation of the one separating the lateral basals, and divides the piece into equilateral halves. As they are of equal size and shape, they will—for the sake of brevity—be described only in the anchylosed form.

Anterior anchylosed basal triangular, with the inner angle at times prolonged into a slender process extending up to or towards the column. Suture-lines between it and the lateral basals generally sinuous.

The second or radial ring contains from six to eight plates, of which the anterior radial and the lateral radials can always be made out, while the posterior radials are generally separate, though

[1] In all species which I have had an opportunity to examine, the dividing suture-line could be made out, including several figured by their describers as being anchylosed.

occasionally merged by anchylosis with the lateral radials, in which case the lower portion of the anchylosed lateral radials extends around and upon the posterior side of the calyx.

The space between the posterior radials or the anchylosed lateral radials is occupied by an azygous plate; and when the brachials belonging to the posterior radials are present, they are crowded down between them and the azygous, and help to form the arch around the consolidated basal piece.

Anterior radial either quadrilateral, usually elongate, and supporting the inferior side of anterior first brachial, or triangular and supporting the lateral radials, which in the latter case meet above it.

The lateral radials are the largest plates of the calyx, and are of variable size and shape, separated by an elongate anterior radial, or else meeting over a triangular one, and always support the anterior brachial between them. Their outer angles, and in case of an anchylosis with the posterior radials, their outer sides, are bent around to the posterior side of the calyx. Their upper and outer sides are inclined posteriorly, and give rise to the lateral arms.

When the arm-bearing function of only one of the posterior radials is suppressed, the brachial lying above it gives support to the anal plates. In case both posterior arms are wanting, both radials support the large median anal plate, either directly or through the intervention of a T-shaped azygous plate lying between them.

Posterior radials, when present as such, lie in the angle formed by the hinge-line between the consolidated basal piece and the lateral radials.

Azygous plate elongate and narrow, T-shaped or broad and low, which latter form is probably due to anchylosis with another plate or plates adjoining.

The anal plate supports a large ventral tube, composed posteriorly of a single series of curved quadrangular plates, "the anterior side being composed of very small and delicate plates."[1]

Anterior arm simple (?) or bifurcating once; if bifurcating, it may be pinnulate. Lateral arms bifurcating at the second brachial, beyond which point they may either increase by regular bifurcation or remain simple, and give off pinnules; or they consist of a series of axillary plates which are attached to the anals by their posterior faces, and more or less completely form an arch over the anal plates, the upper faces being arm-bearing.

Posterior arms when present resemble the lateral arms in structure.

In the following genera, the order of their probable evolution will be followed, and as that was in this case a kind of degener-

[1] Wachsmuth and Springer, "Revision of the Palæocrinoidea," Pt. III., p. 281.

ation or suppression in part,—due to the extreme specialization of certain parts and functions at the expense of others,—the more complex forms will be considered first, because this method represents their natural sequence, and also furnishes an easy introduction to a proper understanding of the component parts of the more specialized forms, and to the nomenclature of the same.

This arrangement will place *Calceocrinus* last, as it is the most specialized form with which we are acquainted, and is consequently furthest removed from the as yet undiscovered or unrecognized five-armed ancestor.

I have revised the family, because the revision of Wachsmuth and Springer,—while a departure in the right direction,—is not quite satisfactory, for the reason that the consolidated base as defined by them agrees only with the base of *Calceocrinus,* and the true relations of the plates of the posterior side are not recognized. The arm-structure also varies more than that revision would indicate.

CASTOCRINUS n. gen.

Calyx hanging against the column, and generally having a slight groove for the reception of it. Column straight or nearly so. Arms four, one anterior, two lateral, and one posterior, the latter being to one side of the median line,—the anal plate and ventral tube occupying the opposite side. Anterior arm simple (?) or bifurcating; bifurcations bearing pinnules.

Lateral arms bifurcating once, with lateral armlets given off on alternate sides at every second joint beyond the place of bifurcation.

Consolidated base with the columnar facet on the posterior portion of the incurved margin. It is composed of two lateral basals, which meet posterior to the column, but are separated anterior to it by the attenuated apices of the anterior basals, or their anchylosed equivalent.

The anterior basals occupy the median portion of the anterior margin of the piece, the lateral basals occupying the outer portions.

Anterior radial higher than wide, usually narrow, and supporting the anterior brachial. Lateral radials irregularly hexagonal. Posterior radials irregularly triangular. Azygous elongate and placed between the two posterior brachials, which extend downwards between it and the posterior radials.

Anterior arm simple (?) or with four or more brachials, upon the last of which a bifurcation takes place. Bifurcations pinnulate; pinnules long; lateral arms having two brachials, the second of which is axil-

lary, and the posterior arm having three, the first of which enters into the formation of the posterior side of the calyx with the brachial of the opposite side. The latter brachial, with the elongate azygous, supports the anal plate, which in turn supports the other plates forming the ventral tube.

Type of genus, *Castocrinus furcillatus* W. R. Billings.

I wish here to express my indebtedness to Walter R. Billings, Esq., of Ottawa, Canada, who very generously placed his types and all the specimens of the genus in his possession at my disposal for the purpose of study.

Below will be found a few remarks on *C. furcillatus*, noting several points not given in the original description, they having been obscured by adherent shale till the specimen came into my hands.

Castocrinus furcillatus W. R. Billings.

Pl. X., Fig. 1.

Calceocrinus furcillatus W. R. Billings.
The Ottawa Naturalist, Vol. I., No. IV., p. 51.

The anterior basals are prolonged to, and form a part of, the columnar facet, not stopping short of it, as represented in the diagram accompanying the original description.

The azygous is elongate and narrow, and extends from the basal plates to the anal plate, the inner corner of which it supports on its sloping upper side. It lies to the left of the median line; the larger of the two posterior brachials—the right—extending up to this line. The inner corner of this brachial is also prolonged upwards beyond the azygous and rests against the inner side of the anal plate.

The incurved margin of the consolidated basal piece is evenly rounded and meets in a narrow connecting band beneath the column.

Trenton formation, Ottawa, Canada. Type in the collection of W. R. Billings.

Castocrinus rugosus W. R. Billings.

Pl. X., Fig 2.

Calceocrinus rugosus W. R. Billings.
The Ottawa Naturalist, Vol. I., No. IV., p. 53.

The position of the consolidated basal in the type specimen is evidently abnormal, as the plates of the posterior side seem to have been pulled downward after it, and out of their proper positions. This was probably caused by the ligaments, which united the two together in

such a manner as to allow of a partial but not complete erection of the calyx upon the base.

Trenton formation, Belleville, Ont. Type in the collection of W. R. Billings.

Castocrinus billingsianus n. sp.

Pl. X., Fig. 3.

Calyx broad, wider than high, base broad, central portion of calyx depressed anteriorly and laterally, just above its middle. Posterior side evenly rounded, with a median furrow for the reception of the column, against which it rests. Anterior arm simple (?), lateral and posterior arms bifurcating. Ventral tube tapering. Column of medium size.

Base of anterior side of calyx with three semicircular depressions, of which the median is the largest, and has the sharpest curvature ; lateral depressions well curved on their inner sides, but gradually rounding out towards the lateral angles. The consolidated basal has a shallow, well-defined, median depression, corresponding to the one on the opposite side of the hinge-line. Lateral depressions but faintly defined. Two ligamentous bands pass over the hinge-line from the dentate projections left on either side of the opposite median depressions.

Consolidated basal piece broad, evenly rounded from side to side, about twice as wide laterally as antero-posteriorly. It is composed of three plates, the anterior basals being anchylosed. Columnar facet situated on the posterior side of the curved portion, from the side of which the column projects in the same general plane as the piece.

Anterior anchylosed basal evenly tapering by slightly sinuous lines to the point of juncture with the column. Its base occupies something over half of the anterior margin of the plate, and has two dentate projections near the lateral angles, receiving the median depression between them.

Lateral basals about as wide at their distal as at their proximal ends.

Anterior radial high, moderately narrow, with a contraction at its upper third ; basal end wider than the brachial end. Lateral radials pentagonal, with the lateral angles truncated.

Posterior radials small, triangular, the right (arm-bearing) radial being somewhat larger than the left.

Azygous unknown. The right posterior brachial is somewhat higher and larger than the left, and has its upper angles projecting upward, and clasping the base of the succeeding brachial between them, differing in this respect from the left pentagonal brachial, which supports the large anal plate. But three anal plates have been observed; they are large, quadrangular, and rapidly tapering towards the apex of the tube.

Anterior arm simple as far as observed, tapering for the first two

joints, from which point it is of nearly uniform size for the next ten. Joints higher than wide.

Lateral arms giving off long, slender, flattened pinnules from every second joint, and identical in structure with those in *C. furcillatus.*

Posterior arm similar in structure to the lateral, but having three brachials before bifurcation takes place.

Column composed of short joints, every alternate or second joint of which is shorter than the others.

From the Trenton formation, Ottawa, Canada. Named in honor of W. R. Billings, Esq., who collected the specimens. Types in Mr. Billings' collection.

This species is readily distinguished by its anchylosed basal; it also differs from *C. furcillatus* and *C. rugosus* in its anterior radial being broadest at its basal end instead of at the brachial end.

Castocrinus articulosus E. Billings.

Pl. X., Fig. 4.

Heterocrinus articulosus E. Billings, Geol. Rep. Canada, Dec. IV., p. 51.

Heterocrinus articulosus Wachsmuth and Springer, Rev. Palæocrinoidea, Pt. I., p. 70.

Calceocrinus (?) *articulosus* E. O. Ulrich, 14th Annual Rept. State Geol. Minn., p. 113.

Surface punctate, like that of *C. rugosus*, from which it differs in the very low and comparatively wide anterior radial, and from all the others here considered in the anterior and lateral radials being more nearly equal in size. The anterior basals have the same shape and size as in *C. rugosus;* lateral basals unknown.

Of the anterior arms only the first brachial is preserved. The lower bifurcation of the lateral arm gives off laterally compressed pinnules, which are strong at their base and wide from without inward: these are given off at the second, fifth, seventh, tenth, and fourteenth joints, beyond which point the division is imperfectly preserved.

The type specimen is rather imperfect, but is distinctive enough to prove it to be a good species.

Type in the collection of the Museum of the Geological and Natural History Survey of Canada.

Castocrinus inæqualis E. Billings.

Pl. X., Fig. 5.

Heterocrinus inæqualis E. Billings, Geol. Survey Canada, Decade IV., p. 51.

Heterocrinus inæqualis Wachsmuth and Springer, Rev. Palæocrinoidea, Pt. I., p. 70.

Cremacrinus inæqualis E. O. Ulrich, 14th Rept. State Geol. Minn., p. 118.

Calceocrinus inæqualis Wachsmuth and Springer, Rev. Palæocrinoidea, Pt. III., p. 282.

The type specimen lies on a slab and shows only the left side, consequently the fourth or posterior arm is obscured. The anterior arm is simple as far as observed, which is about fifteen joints.

Consolidated basal piece composed of two anterior and two lateral basals. The anterior basals extend to the column by quite strong processes.

The lateral arms differ from those of the other Castocrini, in giving off pinnules less frequently and at somewhat irregular intervals, and in not being much enlarged at the points giving rise to them.

This species differs from *C. furcillatus*, in the calyx being more flattened anteriorly and depressed along its median portion, also in the larger anterior basals, the proportionately broader first anterior brachial in comparison with anterior radial, and the very fine, closely arranged punctæ, which of themselves afford an easy means of recognition. It also differs from the foregoing species in the simple anterior arm, in the method of giving off pinnules, and in the character of the lateral arms. From *C. billingsianus* it is distinguished by the surface and by the basals not being anchylosed.

Trenton formation, Ottawa, Canada. Type in the Museum of the Geological and Natural History Survey of Canada.

I am much indebted to Prof. J. T. Whiteaves, of Ottawa, Canada, of the Geological and Natural History Survey of Canada, who kindly loaned me the types of *C. inæqualis* and *C. articulosus*, for the purpose of study and comparison.

CREMACRINUS? Ulrich

This genus will belong here, between *Castocrinus* and *Proclivocrinus*, if Ulrich's diagnosis be correct; but as I have not had an opportunity to examine the type specimen, I will insert it provisionally.

PROCLIVOCRINUS n. gen.

Bilaterally symmetrical; calyx hanging alongside of the column, which is curved posteriorly at its upper end.

Arms three; anterior arm much the largest, simple (?) or not bifurcating till near the tip; lateral arms increasing by regular bifurcation, and not giving off pinnules.

Anal tube large, heavy, and occupying the centre of the posterior side; column round.

Consolidated basal piece triangular, with the posterior angle abruptly truncate at the columnar facet, where it is rounded up. It is composed of four plates, the two anterior of which extend to the column by attenuated processes; their outer portion occupies the middle of the anterior base-line, and does not extend to the lateral angles; suture-line between them and the lateral basals sinuous.

Second ring consisting of six plates; anterior radial high and very narrow, supporting the lower face of the anterior brachial. Lateral radials large, pentagonal, with the lateral angle prolonged to meet the lateral processes of the azygous plate.

Posterior radials rather large, triangular, and each inclosed between the proximate lateral radial, the basal, and the azygous.

Azygous plate broadly T-shaped, and consisting of a middle portion or body, an inferior arm which extends between the posterior radials to the arch around the basal plates, and two lateral arms which meet the processes of the lateral radials, inclosing the posterior radials beneath them; their anterior surface supports the large anal plate. These lateral arms and central body probably represent the first anal plate, while the inferior process is representative of the azygous plate which has been anchylosed to it.

Plates of the ventral tube large quadrangular. First anterior brachial broad. Lateral brachials two, the second of which is axillary; beyond this the lateral arms undergo regular bifurcations at every third or fourth joint. No pinnules observed.

Vault depressed below the margin of, and formed by processes from, the four plates forming the rim of the calyx, *i. e.*, the anterior and lateral radials and the azygous.

Column of medium size, with joints of the curved end arched from side to side so as to fit the antero-posterior depression of the columnar facet.

Type of genus, *Proclivocrinus radiculus* Ringueberg.

Since the original description of the type was published, a number of other specimens have been found which more clearly elucidate points of structure not shown in the type specimen, or obscured by adherent shale, since removed, in that specimen; so that a partial redescription becomes necessary.

Proclivocrinus radiculus Ringueberg.

Pl. X., Fig. 6.

Calceocrinus radiculus Ringueberg. Jour. Cin. Soc. Nat. Hist., Vol. V., p. 120, 1882.

Cremacrinus radiculus E. O. Ulrich. 14th Annual Rept. State Geol. Minn., p. 111, 1886.

Calceocrinus radiculus Wachsmuth and Springer. Rev. Palæocrinoidea, Pt. III., p. 282.

Consolidated basal piece strongly rounded at the point of juncture with the column, where it is of the same shape and size as the column, from which point it spreads out evenly to the flattened anterior margin. This plate is sometimes corrugated, the rugæ passing across it in an antero-posterior direction.

Articular margin furnished with a deep, sharp, ligament-bearing groove.

Lateral basals not forming an incurved margin underneath the column, but only united in the posterior part of the columnar facet, and divided anteriorly by the slender apices of the anterior basals. Anterior basals high, and occupying about one-half of the anterior articular margin of the piece. They taper very rapidly for about one-half of their height, from which point they are prolonged into attenuate processes, extending up to and forming a part of the columnar facet.

Anterior radial high, very narrow, rather abruptly constricted near the middle to one-half of the width of the basal end, which narrowing is continued throughout the brachial half.

Ends of the lateral processes of the lateral radials resting against and as wide as the turned-up portion of the lateral arms of the azygous plate. Posterior radials narrow, with all three sides convex, and the side next to the azygous much shorter than the others.

Azygous plate with the ends of the lateral arms of the plate turned up so as to clasp the base of the anal plate between them.

Posterior plates of anal tube large, quadrangular, and very gradually tapering with the tube; slightly arched posteriorly; but three plates have been seen above the azygous plate.

The five radials, the azygous, and the anterior brachial, seem to be generally consolidated into a single piece, some of the suture-lines being sometimes almost obliterated. These plates are at times also somewhat corrugated, the general direction being transverse.

Specimens vary from those with a strongly rugose surface to those in which it is smooth.

Anterior first brachial just as high as the notch between the upper angles of the lateral radials; second arm-joint tapers more rapidly than the rest. The anterior arm bifurcates at the ninth joint, above which four slender, tapering joints can be counted without further bifurcation.

The lateral arms have two brachials, the second of which is axillary; the anterior division bifurcates again at its third joint, and the lower or posterior undergoes two bifurcations, one at each succeeding fourth joint. Upper division unknown. The posterior primary branch has

two joints, at the second of which a bifurcation takes place, and again at the fourth joint above that.

What were described as lateral armlets in the anterior arm of the type specimen were found, upon further cleaning, to be portions of the lateral arms lying beneath and projecting out from under it, and not from its sides as first supposed.

Column round, smooth, consisting of joints as high as wide, except the last five or six proximal to the calyx, which rapidly get shorter and are higher on the outer side of the column, giving a strong curvature at this point, which still further facilitates the maintenance of the drooping position of the calyx.

The median antero-posterior elevation of the last joints, constitutes a marked somewhat saddle-shaped flexure in the last four; which flexure is received in a corresponding notch in the anterior margin of the articular facet.

Proclivocrinus chrysalis Hall.

Pl. X., Figs. 2 and 13.

Chierocrinus chrysalis Hall. 13th Rept. N. Y. State Cab. Nat. Hist., p. 123.

Calceocrinus chrysalis Shumard. Trans. Acad. Nat. Sci. St. Louis, Vol. II., p. 538, 1886.

Cremacrinus chrysalis E. O. Ulrich. 14th Annual Rept. State Geol. Minn., p. 111, 1886.

Calceocrinus chrysalis Wachsmuth and Springer. Rev. Palæocrinoidea, Pt. III., p. 281, 1886.

This species agrees with *P. radiculus* in the general outline and relations of the plates to each other, but is distinguished by the much broader calyx; calyces corresponding in height being at least a third broader, and also usually less contracted in the middle, than is the case with *P. radiculus.* Hall figures his types as having an anchylosed anterior basal in which the points do not extend to the column. This point, however, is usually so obscure that in all probability it was overlooked in this case, as it has been in others; the same remark will apply to the construction of the posterior side,—as two individuals from the same locality as Prof. Hall's specimens agree very well in other respects with his descriptions. Should the diagram, however, prove to be correct, the specimens here referred to will have to fall under another designation.

This species is readily distinguishable,—as before stated,—from *P. radiculus*, by the much wider calyx and consequently broader plates; this is especially noticeable in the case of the posterior radials.

A unique specimen showing both the articular joint with its connecting ligaments, and the vault,—perfectly,—will furnish all that can be added to the descriptions already published.

The articular joint consists of two deep grooves in the opposite margins, the outer edges of which are widely separated when the crinoid is in its normal position of rest, while the inner two are in close apposition. Over these inner margins pass two bundles of elastic ligaments from one groove to the other.

They each arise in two parts from both sides of the termination of the two suture-lines of the anterior radial; one part coming from the anterior radial and the other from the adjoining lateral radial. These two parts or heads unite and pass over the inner margins of the two adjoining grooves, and are inserted into the groove of the consolidated basal piece, directly opposite their points of origin.

Faint traces of the integument uniting the two outer margins of the grooves and covering the elastic ligaments, can be seen. This integument is better shown in some other specimens of *P. radiculus*, in one of which it is broken up into small pieces which at first glance have the appearance of "numerous little plates," such as are figured by Ulrich in "*Cremacrinus*" *punctatus*.

The vault is covered by four projections from the inner sides of the four plates entering into the formation of the rim of the calyx proper. The top of the vault is smooth and evenly convex, its central portion being depressed to a point opposite one-half the height of the lateral radials, when measured from their lower to their upper angles. The only suture-lines observable are those commencing from the four suture-lines dividing the four plates, which proceed directly from their point of origin to the centre of the vault, where they all meet.

This arrangement gives three large triangular projections and one narrow wedge-shaped one. The outline of the concave space is rounding on the anterior side, with two lateral projections or grooves along the suture-lines, and one such groove in the centre posteriorly.

In the margins of the two lateral radials, can be observed two narrow slits which represent the continuation of the arm-grooves.

I was at first inclined to consider this vault as a kind of partition, serving to strengthen the calyx and taking the function of the basal plates, which no longer served to maintain its rigidity.

From the lower third of the shale at Lockport, N. Y.

The revision of the genus *Calceocrinus* we will preface with a few introductory remarks concerning the original species upon which the genus was founded.

The original description speaks of the semicircular base as consisting of two pieces "anchylosed" (consolidated) together, a triangular one fitting into a somewhat lunate-shaped piece. A more careful examination of two specimens of the same portion of this species, shows a secondary suture-line starting from the

inner angle of the triangular piece, and passing through the excavation for the reception of the column, to the outer margin of the "lunate-shaped" piece, dividing it into equal halves. This suture-line is much less distinct than the other, and is consequently less noticeable. The anterior triangular piece is undoubtedly formed by the union of two anterior radials.

Having determined the composition of the consolidated basal piece of the typical form of *Calceocrinus*, we can place here all such as have the same structure.

This will be done with all that have been found upon examination to correspond to the typical form as shown in a quite perfect individual, so nearly like the type in basal structure and surface markings, that it was at first regarded as a young specimen of that species, but further study shows it to be a closely allied species differing distinctly in some minor details.

A specific description of the original species will be found under *Calceocrinus halli.*

CALCEOCRINUS Hall.

(Revised by Ringueberg.)

Calyx and arms hanging downward and directed outward at an angle from the column.

Column round, bent somewhat posteriorly at its upper portion so as to admit of a greater inclination of the calyx.

Arms three. Anterior arm simple (?) or bifurcating near its terminal portion. Lateral arms consisting of a series of axillary plates attached to, and forming a more or less complete arch over the anals on the posterior side, each of which gives rise to an armlet from its free or distal end.

Consolidated basal piece convex, semicircular, or partially triangular in outline, and formed of three consolidated plates,—two lateral basals and one broadly triangular anterior anchylosed basal, which extends to, or nearly to, the outer angles of the piece.

Column attached to the suture-line dividing the lateral basals, and never coming in contact with the anchylosed anterior basal.

Calyx flattened anteriorly, rounded posteriorly.

Anterior radial triangular, supporting on its two upper sides the adjoining lateral radials. Lateral radials meeting in the median line above the apex of the anterior radial, and supporting in a broadly V-shaped notch between and above them the anterior brachial. Laterally, through anchylosis with the posterior radials, they extend around to and upon the posterior side and assist, with the low and broad

azygous, to form the arch around the curved side of the consolidated basal. They also receive between them the first anal lying immediately upon the azygous.

Their upper and outer sides support the first axillary pieces of the lateral arms.

Lateral arms, formed of from three to five axillary pieces arranged in succeeding order, with their inferior borders resting upon the anal plates and uniting (?), or nearly so, above them in the middle of the ventral side. Their upper ends each give rise to an arm or branch.

Type of genus: *Calceocrinus typus* Ringueberg.

It will be observed from the above description, and the diagram given of *Calceocrinus typus*, that Ulrich's genus *Halysiocrinus* agrees in all of the major points with the typical *Calceocrinus*, of which it must in all probability rank as a synonym. This will also probably be the case with his *Deltacrinus*, unless other and more important structural differences should be noted besides the number of axillaries upon which he bases his genus.

Calceocrinus typus n. sp.

Pl. X., Fig. 8.

Surface finely granulose, calyx flattened anteriorly; somewhat depressed and constricted in the centre of that side; rather square in outline; upper portion but little narrower than the lower; ventral side very gibbous, with a notch or depression to receive the upper end of the column.

Column round, composed of nodose joints which are as high as wide.

Consolidated basal piece evenly semicircular in outline, with the column attached just inside the posterior margin; anterior anchylosed basal half as wide as the base line. Anterior radial almost equilaterally triangular; somewhat wider than the anchylosed basal, but not quite so wide as the base of the calyx. Lateral radials large and anchylosed to the posterior radials; they form the lateral thirds of the arch around the consolidated basal piece on the posterior side, the low and broad azygous occupying the median third.

Azygous wide, slightly lower in the middle on account of the upward curvature of the lower margin receiving the basals, and a downward curvature of the upper margin for the reception of the anal.

First anal broad, low, with outer ends turned up abruptly, and receiving between them the broad base of the truncate pyramidal second anal; other anals, if any, unknown.

Anterior brachial extending somewhat beyond the upper angles of the lateral radials, pentagonal, and having its upper margin hollowed out to receive the first arm-joint.

This first arm-joint differs from the rest, in having a wide base and tapering rapidly towards its upper side, which is of the same width as the succeeding two or three joints. Seven joints are preserved, and no bifurcation takes place.

They are strongly arched, so as to be somewhat wider in their antero-posterior diameter than laterally, and are higher than wide.

Lateral arms composed of series of narrow axillary plates, five in number on each side, of which the first are the highest; being as long as the upper and outer sides of the lateral radials, against which they rest their full length; from these they decrease in height in regular order towards the centre of the arch which they form around the first two anals. Each axillary gives rise to an armlet, in which three joints can be observed, when a bifurcation takes place, or a pinnule is given off (exactly which, cannot well be determined on account of the imperfection of this portion of the specimen). Joints about as wide as long.

From the lower third of the shale of the Niagara Group at Lockport, N. Y.

Calceocrinus Halli n. sp.

Pl. X., Fig. 9.

Calceocrinus —— n. gen. Hall.—Pal. N. Y., Vol. II., p. 352.

Anchylosed base triangular, broadly truncate in outline at the posterior angle, due to the abrupt turning-in of that portion at right angles with the upper surface of the piece. This bending inward extends from this portion along the posterior margins laterally, decreasing gradually towards the outer angles.

Just upon the abrupt posterior curvature of the plate, is situated the excavation for the reception of the articular facet for the column, which is situated at the bottom of it.

Anterior anchylosed basal very low and wide, extending laterally to the outer angles of the basal piece, and having its anterior border sharply grooved along its entire extent, for the reception of the elastic articular ligaments.

Lateral basals broad, due to the lowness of the anchylosed basal; columnar facet situated in about the middle of the suture-line formed by their union.

Surface thickly beset with strong granules, which coalesce to form larger ones on each side of the suture-lines, and upon the posterior curved portion of the plate.

Interior of plate concave, crossed by three grooves, two starting conjointly from the lateral angles and gradually becoming separated. The posterior of these is the deepest and is formed by the projection of a fold or sharp ridge along the line of curvature of the plate, and meets its fellow from the opposite side in the columnar foramen; the othe

follows the suture-line of the anterior anchylosed basal, and incloses a lunate space between it and the other groove. The third groove starts at the columnar foramen and crosses the second groove, passing across the middle of the anterior anchylosed basal to the anterior margin, where it is all that remains of what was probably once a suture-line.

From the lower third of the Niagara Shale at Middleport, N. Y.

This basal piece is readily distinguished from the one be'onging to *C. typus* by not presenting an evenly circular posterior outline, and by the anterior consolidated basal extending to the extreme outer angles. The rest of the calyx has not to my knowledge been found. This species has been named in honor of Professor James Hall, who was its original discoverer and who based the genus upon it.

Calceocrinus bidentatus n. sp.

Pl. X., Fig. 10.

Anterior portion of the calyx flattened, quadrangular in outline, with a slight depression along the median suture-line. The lower margin of the calyx bears upon its upper surface three semicircular depressions with sharply defined margins. The median one of these is the widest and has a smaller one with a sharper curvature on either side, leaving two sharp dentate projections between. Anterior basal high and but little more than half as wide as the base; its two suture-lines commence in the lateral depressions or cicatrices. Anterior brachial projecting somewhat beyond the upper angles of the lateral basals, and having its upper margin slightly curved downward for the reception of the anterior arm.

The outer sides of the lateral radials project but little on the posterior side of the calyx.

This species is of the type of calceocrinoid structure to which *C. stigmatus Hall* belongs, but is at once distinguished from it by the narrower anterior radial, and the fact that the suture-lines of it commence in the lateral cicatrices, instead of passing to the outside of them; various other minor differences can be noted, but the above will prove sufficient for diagnostic purposes.

From the lower third of the Niagara Shale at Lockport, N. Y.

Calceocrinus contractus n. sp.

Pl. X., Fig. 12.

Consolidated basal piece quite convex posteriorly.

Posterior margin truncate. Anterior anchylosed basal extending

laterally to the outer angles. Articular facet for column situated a little inside of the margin, and with its face directed posteriorly.

Associated with the base just described, we find the anterior portion of a calyx that undoubtedly belongs to the same species. Anterior portion of calyx slightly but evenly arched from side to side, lower side wide, rapidly and evenly tapering to the insertion of the anterior brachial, which extends some distance beyond the upper angles of the lateral basals, and tapers more sharply than they do, thus giving the upper portion of the calyx a contracted appearance. Anterior radial broad and low, and extending to the outer angles; thus corresponding in size and proportions to the anterior consolidated basal. Anterior brachial extending for more than half of its height beyond the lateral radials; pentagonal in outline, and wider than high.

From the lower portion of the Niagara Limestone at Lockport, N. Y.

The consolidated basal piece of this species is distinguished from that of *C. halli* of the underlying shales by the much greater proportionate antero-posterior diameter, and by the position of the point of attachment, which is situated nearer to the posterior margin, and has its articular facet directed more nearly posteriorly.

REMARKS: The genus *Cremacrinus* of Mr. E. O. Ulrich is probably the only one of his genera which will hold good. Its pinnulate lateral arms, the punctate surface of the plates, and the sinuous border along the outer margin of the articulation, ally it to *Castocrinus;* while in its having only three arms, and in the arrangement of the plates on the ventral side, it would closely approach *Proclivocrinus;* so that its natural position would be between those two genera. The features distinguishing it from its closest ally *Proclivocrinus* would be those already pointed out as allying it to *Castocrinus,* together with a shorter and broader anterior radial than in *Proclivocrinus,* and in the anterior basals not extending to the columnar facet.

I speak of the anterior arm as "simple (?)" because I believe that all, or nearly all, the species which have been described as having a simple anterior arm, will be found to show a bifurcation, in case specimens are found preserving the arm to its tip.

The plate which is termed the "azygous," in the foregoing descriptions, may prove to be the first anal, and probably in

Proclivocrinus and *Calceocrinus* might more properly be so termed, except for the reason that in them it is the result of an anchylosis and modification of the azygous of the primitive forms with the first anal.

In *Proclivocrinus* the cross-bar of the T represents the first anal, and the stem the remains of the azygous; while in *Calceocrinus* the modification has gone still further, and the stem has become absorbed entirely—only the cross-bar remaining.

The modifications undergone by the members of this family will afford an interesting chapter in evolution, if the material ever presents itself which will allow of its complete working-out.

That the ancestral form was five-armed, there can seem to be no doubt, as the existence of the right brachial in the four-armed *Castocrinus* points conclusively to such a one. But whether this, as yet unknown or unrecognized, ancestor underwent the loss of its fifth arm after the crinoid had assumed the pendulous position of its calyx, and consequently formed a member of the Calceocrinidæ, or sustained this loss first and consequently belonged to another or a new family,—only the finding of it can set at rest.

That *Catillocrinus*,—the affinity of which to the Calceocrinidæ Wachsmuth and Springer have pointed out,—does not belong in the line of their evolution, is shown both by its structure and its geological position; although it may and probably did originate from the same stock.

The course of their specialization and modification of function among the known genera is shown in the successive steps from *Castocrinus* through *Proclivocrinus*, or some allied undiscovered form, to *Calceocrinus*.

But a more complete discussion of the reasons for the suppression of the posterior arms, on account of their being in the way in its new position, and the consequent lateral contraction of the calyx with its concomitant shortening, and the progressive development of the anterior arm and side to make up for the aborted posterior side,—I will leave for another paper at such time as the opportunity for the examination of a more complete series of forms shall present itself.

The types of *Proclivocrinus radiculus*, *Calceocrinus halli*, *C. typus*, and *C. contractus*, are in my collection.

EXPLANATION OF PLATES X. AND XI.

PL. X.

FIG. 1. *Castocrinus furcillatus* W. R. Billings.
a. Right side of type specimen.
b. Left side of same.
FIG. 2. *Castocrinus rugosus* W. R. Billings.
Type specimen.
FIG. 3. *Castocrinus billingsianus* n. sp.
a. Anterior side of calyx.
b. Posterior side of same.
c. Right side of a smaller and nearly complete specimen.
FIG. 4. *Castocrinus articulosus* E. Billings.
Type specimen.
FIG. 5. *Castocrinus inequalis* E. Billings.
Type specimen.
FIG. 6. *Proclivocrinus radiculus* Ringueberg.
a. Type specimen.
b. Specimen showing bifurcation of anterior arm.
c. Anterior side of a calyx with portions of arms.
d. Posterior side of same.
FIG. 7. *Proclivocrinus chrysalis* Hall.
a. Anterior side of a calyx.
b. Posterior side of same.
FIG. 8. *Calceocrinus typus* n. sp.
a. Lateral view of type.
b. Anterior view of same.
FIG. 9. *Calceocrinus halli* n. sp.
a. Outer side of consolidated basal piece of type specimen.
b. Inner side of same.
FIG. 10. *Calceocrinus bidentatus* n. sp.
a. Anterior portion of calyx.
b. Basal portion of same. × 2
FIG. 11. *Calceocrinus stigmatus* Hall.
Base of anterior portion of calyx (after Hall) for comparison with the last, × 2.
FIG. 12. *Calceocrinus contractus* n. sp.
a. Base of an individual.
b. Anterior part of calyx of another.
FIG. 13. *Proclivocrinus chrysalis* Hall.
a. View of the vault of Fig. 7, × 5, to show structure.
b. View of hinge-line of same, × 5, showing elastic ligaments.

PL. XI.

DIAGRAMS ILLUSTRATING STRUCTURE OF THE CALCEOCRINIDÆ.

FIG. 1. *Castocrinus* Ringueberg.

FIG. 2. *Proclivocrinus* Ringueberg.

FIG. 3. *Calceocrinus* Hall (revised by Ringueberg).

a. Right side. *b*. Anterior side. *c*. Posterior side. *d*. Analysis of calyx.

Letters referring to analysis (*d*) :—*b*, *basals*; *r*, radials; *br*, brachials; *ax*, axillary; *an*, anals; *az*, azygous.

The posterior side of the calyx down and the anterior side up.

FIG. 4. Section of *Proclivocrinus*, illustrating the articulation of the base with the calyx and the manner of erection.

c, column ; *cb*, consolidated basal piece ; *ca*, calyx; *l*, elastic ligament; *int*, integument covering ligament; *m*, probable situation of muscles which held the calyx down.

XVIII.—A Revision of the Edentulous Genera of Curimatinæ.

BY CARL H. EIGENMANN AND R. S. EIGENMANN.

Read May 13th, 1889.

This revision is based on the collections in the Museum of Comparative Zoölogy of Harvard University.

It was our intention to write a complete revision of the Characinidæ. The enormous amount of material collected in the Museum of Comparative Zoölogy at Cambridge, Mass., together with the excellent library there, render such a work, based on this collection, greatly to be desired, both for ichthyology in general and for the collections of this Museum in particular. Unfortunately, our work was interrupted shortly after it was begun.

Professor Louis Agassiz, under whose direction this material was accumulated, has been frequently criticised for his seemingly extravagant statements regarding the number of new species found by himself and his assistants during the Thayer expedition in Brazil. Although Professor Agassiz may have been misled by the necessarily hasty comparisons made while collecting, it is due to his memory to state that he was far nearer the truth than has generally been supposed. Few of the new species discovered by Professor Agassiz were based on his specimens. Many of them had been collected before by Natterer, though they had not been described when Professor Agassiz made his collection; and Dr. Steindachner has based many of his new species on Natterer's specimens preferably to those of Agassiz. Since Prof. Agassiz made his expedition, many others have collected in Brazil, and their specimens have been described by Doctors Günther, Boulenger, Steindachner, Cope, Gill, and others; while Professor Agassiz's material remained untouched at Cambridge. In spite of these facts, there yet remain one or two hundred undescribed species of Characinidæ alone, in the Museum at Cambridge, if we may judge from the Erythrininæ and Curimatinæ which we examined. Our studies of the Nema-

tognathi have demonstrated a similar state of affairs among that group.

The key to the species of the genus Curimatus may prove to be erroneous or insufficient in parts. If so, it is due to the fact that we could not have the specimens before us when revising the key. One species of Curimatus, *C. alberti*, has been omitted, as we had no description of it. Dr. Günther, in his paper on the fishes of the Rio Plata, states that it is related to *Curimatus platanus*, but with considerably larger scales.

In order to shorten the references in the synonymy, the titles of works are not quoted, but each paper is referred to as "a," "b," etc., after the year of its publication. "Steind., '75c" refers to Dr. Steindachner's paper, "Die Süsswasserfische des südöstlichen Brasiliens," as will be seen by referring to the Bibliography given at the end of our paper. When but one paper was published in the year by an author, it is referred to by the year of its publication, as: "Gthr., '64" refers to vol. v. of Dr. Günther's Catalogue of the Fishes of the British Museum.

The genera of the edentulous Curimatinæ may be distinguished by the following key:

a. Gill-arches with long, slender rakers. ANODUS.

aa. Gill-arches without rakers.

- *b*. Postventral region trenchant, the scales of each side with a narrow margin bent over the ventral ridge and terminating medially in a spiniform process.
  - *c*. Scales in lat. l. 94–103. Preventral region flat, with blunt lateral keels. Median line in front of dorsal naked. A. 16–17. POTAMORHINA.
  - *cc*. Scales in lat. l. 50–60. Preventral region rounded. Predorsal region entirely scaled. A. 10-12. PSECTROGASTER.
- *bb*. Postventral region trenchant or not, always with a median series of scales which do not terminate in spiniform processes.
  - *d*. Lateral line developed on anterior scales only; mouth oblique, the lower jaw entering the profile. Tongue long and narrow, quite free. CURIMATOPSIS.
  - *dd*. Lateral line complete. Mouth horizontal or slightly oblique. Tongue short and thick, adnate. CURIMATUS.

I. ANODUS.

ANODUS Spix, '29a, 60 (*elongatus* and *latior*); M. and T., '45a, 6 (sp.); Cope, '78a, 682 (*elongatus*).

ELOPOMORPHUS Gill, '78a, May 21st (*jordani*).

Type, *Anodus elongatus* Spix.

A genus of Curimatinæ with clupeiform branchial apparatus. Three species, confined to the Amazons and their tributaries from Villa Bella to Peru.

1. ANODUS MELANOPOGON.

Anodus melanopogon Cope, '78a, 682 (Peruvian Amazon).

Slender, head elongate. Muzzle acuminate, mandible projecting. Eye 6 in head, 1¼ in snout, 1¼ in interorbital. Opercle as deep as long. Origin of dorsal little nearer to tip of snout than to base of caudal. Pectorals reaching half-way to ventrals, ventrals half-way to anal. Blackish above, sides and abdomen silvery. Dorsal and caudal dusky. End of mandible black.

Head 3⅔; depth more than 6; D. I. 10; A. I. 10; V. 11; P. 19. Lat. l. 128.

COPE.

2. ANODUS STEATOPS.

Anodus steatops Cope, '78a, 683 (Peruvian Amazon).

Jaws equal. A large adipose lid reducing the ocular opening to a vertical slit. Eye 2 in interorbital, more than 5 in head; opercle deeper than long. Origin of dorsal equidistant from tip of snout and base of upper caudal fulcra. Steel-blue, paler below; base of the caudal extensively black, other fins unspotted; sides of head and operculum above orbit golden; chin and top of head black.

Head 3.6; depth 5.3; D. I. 10; A. I. 11; V. 12; P. 19. Lat. l. 93.

COPE.

3. ANODUS ELONGATUS.

Piaba branco.

Anodus elongatus Spix, '29a, 61, pl. 40.

Curimatus elongatus Cuv. and Val., xxii., 20; Castelnau, '55a, 58 (Amazons); Kner, '59a, 146 (Forte do Principe); Gthr. '64, 293 (copied).

Elopomorphus elongatus Steind., '81a, 38 (Forte do Principe; Villa Bella).

Elopomorphus jordani Gill, '78a, May 21st, and '78b, 112.

Habitat, Northern Brazil.

2. POTAMORHINA.

POTAMORHINA Cope, '78a, 685 (*pristigaster*).

Type, *Curimatus pristigaster* Steind.

A genus of a single species. The clupeoid belly, flat breast, naked predorsal line, and small scales, serve to distinguish it from the related genera.

POTAMORHINA PRISTIGASTER.

Curimatus (*Anodus*) *pristigaster* Steind., '76a, 25, pl. VI. (Teffé; Barra do Rio Negro).

Potamorhina pristigaster Cope, '78a, 685 (Peruvian Amazon).

Habitat, Amazons from Barra do Rio Negro to Peru.

Fifteen specimens, .18—.29 m. Teffé; Lake Hyanuary.

Compressed. Preventral region flat or slightly concave, with blunt lateral keels; postventral region strongly compressed, with a series of spiniform scales. Median line before dorsal naked; postdorsal region rounded. Scales small, all very strongly ctenoid.

Head depressed above the eyes; eye about equal to snout, 2 in the interorbital.

Origin of dorsal about an orbital diameter nearer to tip of snout than to base of upper caudal rays. Caudal rays much branched. Anal emarginate; pectorals reaching past the origin of ventrals.

Air-bladder extending beyond origin of anal.

Yellowish, with brassy reflections; a black spot at end of lateral line.

Head $3\frac{1}{3}$–$3\frac{2}{7}$; depth $2\frac{1}{3}$–$2\frac{1}{5}$; D. 12–13; A. 16–17. Lat. l. 94–103.

3. PSECTROGASTER gen. nov.

Type, *Psectrogaster rhomboides* sp. nov.

Teeth none. Lateral line developed. Postventral region trenchant, the scales of each side with a narrow margin bent over the ventral ridge and terminating medially in a spiniform process. Preventral region rounded; predorsal region entirely scaled. Scales 50–60.

This genus is closely related to Potamorhina, from which it differs in having much larger scales, etc.

Analysis of the species:—

a. Air-bladder extending to origin of anal. Origin of dorsal about equidistant between tip of snout and base of upper caudal fulcra. Origin of ventrals nearer to base of caudal than to tip of snout. Scales 15–55–10. *rhomboides*, 1.

aa. Air-bladder extending to posterior end of anal. Origin of dorsal about equidistant from tip of snout and from tip of adipose fin.

b. Depth ♂ and ♀ about $2\frac{1}{4}$. Lat. l. 49–56. *amazonica*, 2.

bb. Depth ♀ $2\frac{1}{6}$. Scales 56. Profile convex. *ciliatus*, 3.

1. PSECTROGASTER RHOMBOIDES sp. nov.

Curimatus cyprinoides Steind., '81a, 34 (Rio Puty), not of L., Gthr., et al.

Types, No. 20303, 20304, 20306, over fifty specimens, Rio Puty; O. St. John.

No. 20310, one specimen, San Gonçallo; O. St. John.

Compressed rhomboidal, the dorsal and ventral outlines making angles at the origin of the dorsal and of the ventral fins. Preventral region rounded. Postventral region trenchant, without a median series of scales. The scales of each side with a narrow margin bent over the ventral ridge and terminating medially in a spiniform process. Back narrow, without keels.

Profile more or less depressed at the occiput. Eye with a narrow anterior and posterior adipose lid, about 1 in snout, $3\frac{1}{2}$–4 in head, $1\frac{3}{4}$–2 in interorbital.

Scales small on back, becoming larger towards the breast, where they are several times as large as on the back. Scales of the breast pectinate, the rest more or less ciliate. Caudal naked.

Air-bladder extending to origin of anal.

Origin of dorsal about equidistant between tip of snout and base of upper caudal fulcra, in a few specimens nearer the caudal; the highest ray shorter than the head. Caudal broad, emarginate. Anal short, emarginate, the tip of the longest ray reaching the tip of the last ray. Pectorals reaching scarcely to ventrals, ventrals not to vent. Origin of ventrals nearer base of caudal than tip of snout. Plumbeous above, gradually becoming lighter below. A dusky area on the base of the caudal at end of lateral line.

Head $3\frac{1}{5}$–$3\frac{1}{3}$; depth $2\frac{1}{4}$–$2\frac{3}{5}$. D. 12–13; A. 10–11. Scales 14 to 16–53 to 58–10 or 11.

2. PSECTROGASTER AMAZONICA sp. nov. ?

? *Anodus ciliatus* M. and Tr.

Habitat, Amazons.

Many specimens: Teffé; Iça; Tabatinga; Obidos; Fonteboa; Lago Alexo; Jutahy; Tonantins; Santarem; Hyavary; Curupira.

This species agrees in almost all respects with *Psectrogaster rhomboides*.

Profile very little, if at all, depressed at the occiput.

Air-bladder extending to posterior end of anal.

Origin of dorsal fin about equidistant from tip of snout and from tip of the adipose fin. Origin of ventrals nearer to tip of snout than to base of caudal.

Head about $3\frac{2}{3}$; depth about $2\frac{1}{4}$. D. 12–13; A. 11–12. Scales 12 or 13 –49 to 56–9.

3. PSECTROGASTER CILIATA.

Anodus ciliatus M. and Tr., '45a, 25, pl. IV., fig. 4 (Essequibo); id. '48a, 633 (Lake Amucu).

Curimatus ciliatus Castelnau, '55a, 58 (Amazon); Kner, '59a, 143 (Ypanema; Guapore); Gthr. '64, 292 (copied).

Habitat, Amazon and its tributaries; Guiana. Rare.

Six specimens from Coary may be referred here. The male of this species (?) cannot be told from specimens of *amazonica*. The female is strikingly deeper than *amazonica*. The largest specimen measures .18 m.

Profile convex. Origin of dorsal in females about equidistant from tip of snout and base of upper caudal fulcra. Origin of ventrals about equidistant from tip of snout and base of caudal—considerably nearer base of caudal in largest specimen. Depth $2\frac{2}{7}$ ♂–$2\frac{1}{6}$ ♀. D. 12–13; A. 11–12. Scales 12–56–9 or 10.

4. CURIMATOPSIS.

CURIMATOPSIS Steind., '76a, 33 (*macrolepis*).

Type, *Curimatopsis macrolepis* Steind.

This genus, as far as known, is composed of two species. It is closely related to *Curimatus*.

Teeth none. Lateral line developed on anterior scales only. Mouth oblique, lower jaw entering the profile. Tongue long and narrow, quite free.

1. CURIMATOPSIS MACROLEPIS.

Curimatus (*Curimatopsis*) *macrolepis* Steind., '76a, 33 (Tabatinga; Manacapuru; mouth of the Rio Negro).

Habitat, Amazons and tributaries from Rio Negro to Tabatinga.

Numerous specimens, .035–.07 m. Tabatinga; Lake Hyanuary; Cudajas.

Compressed elongate. Preventral region flattish, without enlarged scales; postventral region rounded; predorsal region to near the dorsal flattened; postdorsal region rounded. Scales cycloid, 4–6 longitudinal ridges on each scale; caudal scaled at base only.

Profile from nares straight, convex near the dorsal.

Eye 3 in the head, 1¼ in the interorbital.

Origin of dorsal fin a little nearer to tip of snout than to base of caudal. Anal emarginate. Pectorals not reaching ventrals: ventrals about to the vent; their origin a little nearer to base of caudal than to tip of snout.

Air-bladder extending to the anal.

Depth of caudal peduncle about 2 in the head.

Light brown, with silvery reflections; a lighter line through centre of scales; a silvery lateral band terminating in a large black spot at base of caudal.

Head 3–3½; depth 2¾–3¼. D. 11–12; A. 11. Lat. l. 30.

2. CURIMATOPSIS MICROLEPIS sp. nov.

Type, No. 20,844, one specimen, .115 m. Jatuarana. M. Navez.

Compressed elongate. Dorsal and ventral outlines equally arched. Back and belly rounded.

Profile very little depressed. Margin of lower jaw rounded. Eye little longer than snout, 3½ in head, 1⅔ in interorbital.

Scales all small, entire. Caudal naked. Lateral line developed on about 12 scales only.

Origin of dorsal equidistant from tip of snout and base of upper caudal fulcra. Anterior dorsal rays prolonged, reaching the adipose fin. Anal slightly emarginate, the anterior rays reaching tip of last rays. Pectorals not nearly reaching to ventrals; ventrals not to vent.

Light brown, with iridescent metallic reflections. Margins of the jaws

and inner surface of the lower jaw dark brown. A U-shaped dark bar in base of mouth. Inner surface of opercle with brown dots.

Head 3½; depth 3. D. 12; A. 11. Scales 14–60–?.

5. CURIMATUS.

◁ Les Curimates Cuvier, Règne Animal, II., 165, 1817 (*edentulus*).

Type, *Salmo edentulus* Bloch.

This genus may be divided into a number of groups which are probably of subgeneric rank. They are: 1. Those species with the caudal entirely scaled. 2. Those with the postventral region rounded. 3. Those with the postventral region trenchant. 4. Those with more than 80 scales in the lateral line.

* Lateral line less than 80.

† Caudal lobes thickly scaled to their tips. (Curimatella subg. nov.)

a. Scales 9–48 to 45–7. *lepidurus*, 1.

a_2. Scales 5 or 6–33 to 41–5.

b. Depth 3⅔–3⅓ in the length. *meyeri*, 2.

b_2. Depth 3, or less than 3, in the length.

c. Scales 6–39 to 41–5. Predorsal region sharply keeled. *serpæ*, 3.

c_2. Scales 5–36 to 38–5. Predorsal region broad, with indistinct median keel. *alburnus*, 4.

c_3. Scales 33 to 35. A blackish longitudinal line on the scales of the back. *alburnus lineatus*, 4a.

††. Caudal lobes mostly naked. (Curimatus).

‡ Postventral region rounded or with an obtuse median keel.

d. Sides without spots.

e. A black spot at base of middle caudal rays.

f. Dorsal plain. Sides without a dark line

g. Lateral line 33 to 35.

h. Depth 2¾ to 3⅓ in the length.

i. Predorsal region depressed or grooved to near the dorsal. *spilurus*, 5.

i_2. Predorsal region keeled. *spilurópsis*, 6.

h_2. Depth 2¼ to 2½. Predorsal region keeled. *dorsalis*, 7.

g_2. Lateral line more than 40.

j. Lateral line 42 to 43. *nasus*, 8.

j_2. Lateral line 46. No adipose eyelids. *troschelii*, 9.

f_2. Base of middle dorsal rays dark.

k. A dark line on sides. Lat. l. 33 to 37.

l. Depth 3½–3¾. *elegans*, 10.

l_2. Depth $2\frac{2}{3}$–3. *elegans bahiensis*, 10a.

k_2. No dark line on sides.

m. Scales 37. *argenteus*, 11.

m_2. Scales 8–44 to 47–5; dorsal and caudal spots distinct. *bimaculatus*, 12.

m_3. Scales 8–48 to 52–6; dorsal and caudal spots indistinct or wanting. A brown bar at base of caudal. *bimaculatus sialis*, 12a.

e_2. Middle caudal rays plain.[1]

n. A black spot at base of dorsal.

o. Lateral line 48 to 52. *bimaculatus trachystethus*, 12b.

o_2. Lateral line 43. *dobula*, 13.

o_3. Lateral line 34. *güntheri*, 14.

n_2. Dorsal plain.

p. Back uniform in color.

q. Less than 60 scales in the lateral line.

r. Lateral l. 32–34. *microcephalus*, 15.

r_2. Lateral l. 36–41.[2]

s. Ventrals not reaching to the vent.

t. Preventral region without a median series of enlarged scales. *gilberti*, 17.

t_2. Preventral region with a median series of enlarged scales. *gilberti brevipinnis*, 17a.

s_2. Ventrals reaching to vent. *plumbeus*, 18.

r_3. Lateral l. 44–47.

u. D. 10; scales 8–44–7. *nägelii*, 19.

u_2. D. 12–13; scales 7–45 to 47–6. *leucostictus*, 20.

r_4. Lateral l. 49 to 55.

v. Depth $2\frac{1}{3}$–3.

w. Scales entire. *platanus*, 21.

w_2. Scales serrated.

x. Scales 13 or 14–51–9; mouth subinferior. *asper*, 22.

x_2. Scales 11 or 12–50 to 53–8. *rutiloides*, 23.

v_2. Depth 4. *hypostomus*, 24.

q_2. Lateral line with 60 or more scales.

y. Scales 16 or 17–69 or 70–12 or 13. *mivartii*, 25.

y_2. Scales 10–60 to 69–8. *leuciscus*, 26.

p_2. Back with dark cross-bars. *vittatus*, 27.

[1] In order to bring this index within the proper limits of the page-width, the position of e_2 has been transferred at this point to the left-hand edge.

[2] 16, *C. magdalenæ* should be placed here.

d_2. Sides with a dark spot at the fortieth scale. *ocellatus*, 28.
‡‡. Post-ventral region trenchant.
a. Preventral region rounded; jaws equal. *isognathus*, 29.
a_2. Preventral region angular.
b. Some of the dorsal rays prolonged in a filament.
c. Lateral line 60 to 64. *knerii*, 30.
c_2. Lateral line 56 to 60. *cyprinoides*, 31.
b_2. Dorsal rays not produced.
d. Scales 16–61 to 70–10. *macrops*, 32.
d_2. Scales 14–64–11. *falcatus*, 33.
d_3. Scales 14–51 to 53–6. *simulatus*, 34.
d_4. Scales 13–55–8. *schomburgkii*, 35.
d_5. Scales 12–51–9. *essequibensis*, 36.
**. Lateral line 85 to 110. Median line in front of dorsal naked in adult. (SEMITAPICIS[1] subg. nov.)
a. Preventral region rounded.
b. Postdorsal region trenchant. *planirostris*, 37.
b_2. Postdorsal region rounded. *laticeps*, 38.
a_2. Preventral region trenchant. *latior*, 39.

1. CURIMATUS LEPIDURUS sp. nov.

Types, Nos. 20,291 and 20,292, five specimens, .075–.10 m. to base of caudal. Rio San Francisco below the falls; C. F. Hartt.

Closely related to *alburnus*, from which it differs chiefly in the number of scales.

Compressed, dorsal outline more irregular than the ventral outline, which is evenly curved to the anal. Preventral region rounded or slightly flattened; postventral region more narrowly rounded. Predorsal region broad, with a distinct median and indistinct lateral keels; postdorsal region rounded, or with three indistinct keels. Scales persistent, all but those of the breast entire. Lateral scales all of about the same size, each scale with two diverging ridges. Caudal lobes thickly scaled to near their tip.

Profile scarcely depressed over the eyes. Eye little longer than snout, 3–$3\frac{1}{3}$ in head, $1\frac{3}{4}$ in interorbital. A very narrow anterior and posterior adipose lid.

Highest dorsal ray a little shorter than the head. Anal short, somewhat emarginate. Pectorals not reaching to ventrals, ventrals not to vent.

Sides and lower parts yellowish, back bluish. Each scale of the sides with a narrow median line of golden.

Head $3\frac{1}{4}$; depth $2\frac{1}{4}$–$2\frac{2}{3}$. D. 12–13; A. 11–12. Scales 9–43 to 45–7.

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[1] Semita = a path, apex = crown, in allusion to the naked predorsal line.

2. CURIMATUS MEYERI.

Curimatus meyeri Steind., '82a, 11, pl. I., fig. 4 (Huallaga).

Habitat, Huallaga; Obidos; Manacapuru.

A single specimen, .10 m. long, from Obidos, and another, .12 m., from Manacapuru, may represent this species.

Head 3⅗; depth 3⅓. D. 13; A. 10. Scales 6–40–?.

3. CURIMATUS SERPÆ sp. nov.

Types, No. 20,320, four specimens, .065–.075 m. to base of caudal. Serpa; Thayer.

A beautiful species, related to *alburnus*, *meyeri*, and *immaculatus*, differing in the proportions, scales, etc.

Elongate slender. Preventral region depressed, without lateral keels; postventral region with three indistinct keels. Predorsal region sharply keeled to the occipital crest. Postdorsal region with three indistinct keels.

Scales cycloid, persistent, their surface with two widely diverging ridges. All the caudal rays thickly covered with scales to near their tip.

Anterior profile straight, upper profile but little convex. Mouth subterminal. Eye 3–3½ in head, 1⅓–1⅔ in interorbital, which is equal to the depth of the head at the pupil.

Dorsal much higher than long, its highest ray longer than the ventral, shorter than the head. Anal truncate, the anterior rays much longer. Pectorals not reaching to ventrals, which do not reach the vent.

Air-bladder extending to middle of anal.

Light-brown above, silvery below, everywhere with metallic reflections. Dorsal scales with a brownish spot as in *meyeri* and *alburnus*.

Head 3¼–3⅖; depth 3. D. 12–13; A. 10–11. Scales 6–39 to 41–5.

4. CURIMATUS ALBURNUS.

Anodus alburnus M. and T., '45a, 26, pl. IV., fig. 3 (Lake Amucu, British Guiana); id. '48a, 633 (Lake Amucu).

Curimatus alburnus Kner, '59a, 144 (Rio Guapore; Matto Grosso); Gthr., '64a, 289 (copied); Steind., '76a, 33 (Teffé); id. '79a, 5 (Orinoco near Ciudad Bolivar); id. '81a, 36 (Amazon).

Habitat, Northern Brazil and northward.

About 55 specimens, .13–.22 m. Surinam; Coary; Lake Hyanuary; Rio Negro; Jutahy; Ueranduba; Teffé; Manacapuru; Hyavary; Tonantins.

Stout, tapering backward; preventral region flattened, a median series of large scales, and bluntly keeled scales in the lateral series;

postventral region with median and lateral keels which converge towards the anal. Predorsal region broad, with indistinct median and lateral keels; postdorsal region rounded or with three keels.

Scales persistent, crenate or serrate margined; lateral scales with two or three diverging ridges. Caudal lobes scaled to the tip in all specimens.

Profile scarcely depressed over the eyes. Eye $3\frac{1}{3}$–$3\frac{1}{2}$ in head, $1\frac{1}{6}$–2 in interorbital.

Air-bladder extending to the anal.

Origin of dorsal about equidistant from tip of snout and tip of adipose. Highest dorsal ray little longer or shorter than head. Anal emarginate, the tips of some of the anterior rays reaching the caudal. Ventrals considerably shorter than head, not reaching the vent.

Scales above the lateral line usually with a golden base and a crescentiform dark spot parallel with the margin, remaining parts golden. Sometimes uniform steel blue, without markings.

Head $3\frac{2}{3}$–$3\frac{1}{2}$; depth $2\frac{1}{2}$–3. D. 12–13; A. 10–11. Scales 5–36 to 38–5.

4a. CURIMATUS ALBURNUS LINEATUS. var. nov.

Type, No. 20,297, one specimen, .09 m. Jutahy; James, Thayer, and Talisman.

Color of *alburnus*, but the dorsal scales with a blackish median line.

Depth $2\frac{5}{6}$. D. 13; A. 10–11. Lat. l. 33–35.

5. CURIMATUS SPILURUS.[1]

Curimatus spilurus Gthr., '64, 288 (Essequibo); Steind., '76a, 31 (Hyanuary; Iça; Teffé; Rio Negro); Cope, '78a, 684 (Peruvian Amazon); Steind., '79a, 5 (Orinoco near Ciudad Bolivar).

Habitat, Northern Brazil and northward.

About two hundred specimens, .045–.12 m. Iça; Teffé; Jutahy; Cudajas; José Fernandez; Lake Hyanuary: Alexo; Ueranduba; Jatuarana; Obidos.

Compressed elongate. Preventral region flattened, with a median series of large scales; postventral surface rounded, the large scales of the median series slightly carinate. Predorsal region depressed or grooved to near the dorsal; postdorsal region rounded.

Scales perfectly smooth-edged in the smaller examples, slightly dentate in the largest specimens. Lateral line complete. Scales only on the base of the caudal lobes. Lateral scales with two longitudinal ridges.

Profile from nares to near dorsal straight and not very steep. Eye $3\frac{1}{3}$ in head, $1\frac{1}{5}$–$1\frac{1}{3}$ in the interorbital.

Air-bladder extending to the anal.

Origin of dorsal about midway between tip of snout and tip of adipose. Anal emarginate, pectorals not reaching to ventrals, ventrals about to vent. Origin of ventrals midway between tip of snout and base of caudal. Depth of caudal peduncle little more than 2 in head.

Light brown with silvery and bluish reflections, a plumbeous median band terminating in a black spot at base of caudal.

Head 2½–4; depth 2¼–3 (2½ in some specimens according to Günther). D. 13; A. 10–11. Lat. l. 33–35.

6. CURIMATUS SPILUROPSIS sp. nov.

Five specimens, No. 20,218, .075–.09 m., collected by Mr. W. James at Iça, have the ventral profile almost straight and the back greatly elevated. The back in front of the dorsal is strongly convex and the median series of scales keeled. Preventral surface flat, postventral surface rounded.

Scales smooth-edged, the ridges scarcely evident.

Mouth entirely below the level of the orbit.

Origin of ventrals a little nearer to base of caudal than to tip of snout.

Caudal spot indistinct.

Depth 2⅘–3, otherwise as in *C. spilurus*.

Three other specimens, also from Iça, have no caudal spot.

7. CURIMATUS DORSALIS sp. nov.

Types, No. 20,183, one specimen, .09 m. Coary; L. Agassiz.
No. 20,210, one specimen, .09 m. Manacapuru; W. James.
No. 20,241, one specimen, .082 m. Hyavary.
No. 20,330, one specimen, .09 m. Obidos; Col. Bentos.

Habitat, Amazon, Solimoens and tributaries.

Related to *C. spilurus*. Compressed dorsadiform; preventral region flattened, with a median series of large scales; postventral region with two indistinct lateral keels, the median series of scales arched. Predorsal greatly arched and with a median keel; postdorsal region rounded.

Scales persistent; the broadly rounded posterior margin crenate; the surface with indistinct longitudinal ridges or none. Basal half of the caudal rays scaled. Pores of the anterior scales of the lateral line imperfectly developed or wanting.

Profile greatly arched behind the occiput, and conspicuously depressed at the occiput. Eye 2⅔–3 in head, 1½–1⅘ in interorbital.

Air-bladder terminating in a filiform process which rests against the anterior surface of the first interhæmal.

Origin of dorsal midway between tip of snout and tip of adipose. Anal short, emarginate. Pectorals not reaching to ventrals, ventrals to vent. Origin of ventrals about equidistant from tip of snout and base of caudal.

Light brown above with bluish or silvery reflections; a pale lateral band margining the brown of the back; a blackish spot at base of caudal.

Head $3\frac{2}{3}$; depth $2\frac{2}{3}$–$2\frac{1}{2}$. D. 13; A. 10–11. Scales 5 or 6–35–5.

8. CURIMATUS NASUS.

Curimatus nasus Steind., '82, 20, pl. V., fig. 2 (Canelos, Ecuador).

9. CURIMATUS TROSCHELII.

Anodus troschelii Gthr., '59, 418 (Western Andes of Ecuador).
Curimatus troschelii Gthr., '64, 290; Steind., '80a, 40 (Guayaquil).

10. CURIMATUS ELEGANS.

Curimatus elegans Steind., '74a, 31 (Rio Arassuahy, tributary of the Jequitinhonha).

Habitat, streams of southeastern Brazil.

Six specimens, about .10 m. Rio Arassuahy; Rio Ipajica at Pernambuco; Bahia.

A species which can readily be recognized by its peculiar color-markings.

Elongate slender. Preventral region rounded or slightly depressed; postventral region rounded. Predorsal region with an indistinct median keel; postdorsal region with three keels. Dorsal and ventral outlines gently arched.

Profile regularly convex; premaxillary broad, the snout projecting considerably beyond the mouth. Eye $3\frac{1}{2}$ in head, $1\frac{1}{2}$ in interorbital.

Scales mostly smooth-edged.

Pectorals not reaching to ventrals, ventrals not to vent.

Light brown above, silvery below, everywhere with metallic reflections; a silvery lateral band. Lateral line bordered by black; an elongate blackish spot at base of caudal; two middle rays and lower lobe of caudal dusky; a blackish spot at base of middle dorsal rays.

Head $3\frac{3}{8}$–$3\frac{3}{4}$; depth $3\frac{1}{5}$–$3\frac{3}{4}$. D. 12–13; A. 10–11. Scales 35–37.

10a. CURIMATUS ELEGANS BAHIENSIS var. nov.

Types, No. 20,324 and 20,325, forty-four specimens, .052–.11 m. Bahia; Thayer expedition.

Depth $2\frac{3}{5}$–3. Back always greatly arched. Lat. l. 33–35.

11. CURIMATUS ARGENTEUS.

Silver-fish.

Curimatus argenteus Gill, '58, 62 (Trinidad); Gthr., '64, 289 (copied); Lütken, '74a, 225 (Trinidad).

12. CURIMATUS BIMACULATUS.

Curimatus bimaculatus Steindachner, '76a, 28 (Hyavary).

Habitat, Amazon, Solimoens.

Many specimens from Hyavary and Coary, Villa Bella, Iça; the largest .17 m.

This species can readily be distinguished by its color-markings.

Compressed, ventral outline nearly straight to the anal, back greatly arched. Preventral region broad and flat, without distinct lateral keels; postventral region rounded, with three indistinct keels. Predorsal region with a prominent median keel; postdorsal region rounded.

Scales thin, persistent, pectinate or serrate. Caudal naked.

Profile slightly depressed at the occiput, more or less strongly arched behind it. Eye 1 in snout, 3½ in head, 1½ in interorbital.

Mouth inferior, head depressed.

Air-bladder extending to anal.

Caudal broad and deeply emarginate. Anal high, emarginate; some of the anterior rays extending past origin of caudal. Ventrals reaching to or past the vent; pectorals not to ventrals.

Bluish above, silvery on sides and below. A blackish spot at base of middle caudal rays, another at base of middle dorsal rays, usually another spot on the back just in front of the dorsal fin; an opaque whitish spot at the base of each caudal lobe.

Head 4; depth 2⅘–3½. D. 12-13; A. 11. Scales 8–44 to 47–5.

12a. CURIMATUS BIMACULATUS SIALIS var. nov.

Types, No. 20,206, nine specimens, .09–.19 m. Manacapuru; W. James.

This variety differs from the typical *bimaculatus* in having the dorsal and caudal spots very faint, or more often they are not present. A straight, or more usually a dumb-bell-shaped, brown spot at base of caudal. Those with a straight caudal spot have the predorsal region plain; those with a dumb-bell-shaped spot have a blackish spot in front of dorsal and another behind the occipital process, and have the scales more pectinate than the other specimens. Scales 8–48 to 52–6.

12b. CURIMATUS BIMACULATUS TRACHYSTETHUS.

Curimatus trachystethus Cope, '78a, 684 (Peruvian Amazon).

Habitat, Amazons from Serpa to Peru.

Our specimens differ from those described by Dr. Cope, in having a distinct, though low, postventral keel. Serpa; Fonteboa; Tabatinga.

Ventral outline somewhat more arched than in *bimaculatus.*

Scales serrate or crenate.

Pectorals in one specimen reaching ventrals.

Color as in *bimaculatus*, without the caudal spot. A blackish spot behind tip of occipital process. Scales 8–48 to 52–6 to 7.

13. CURIMATUS DOBULA.

Curimatus dobula Gthr., '68a, 248 (Huallaga); Boulenger, '87b, 279 (Canelos).

Habitat, Eastern slopes of Peru and Ecuador.

14. CURIMATUS GÜNTHERI sp. nov.

Type, No. 20,245, one specimen, .085. Tabatinga; Bourget.

We have dedicated this beautiful species to Dr. Albert Günther, of the British Museum.

Resembling *spilurus* in shape of body. Preventral region flat, with obtuse lateral keels; postventral region rounded. Predorsal region with a median keel; postdorsal region rounded.

Scales mostly entire, those of the breast crenate. Scales on the base of the caudal lobes.

Profile rounded, not depressed at the occiput. Eye $\frac{3}{4}$ in snout, 3 in head, $1\frac{1}{4}$ in interorbital.

Caudal deeply forked, the lobes longer than the head. Pectorals not reaching to ventrals, ventrals to vent.

Brownish above, silvery below, everywhere with metallic reflections; a white lateral band. A conspicuous dark brown spot at base of middle dorsal rays.

Head $3\frac{1}{2}$; depth $2\frac{3}{5}$. D. 13; A. 11. Scales 5–34–5.

15. CURIMATUS MICROCEPHALUS sp. nov.

Types, No. 785, four specimens, .07–.145 m. Surinam; Dr. J. Wyman.

Rather deep, the dorsal and ventral outlines regularly, the latter more regularly, arched. Region immediately in front of ventrals flattened; breast rounded. Postventral region with three indistinct keels. A few scales in front of the dorsal keeled, the rest rounded; postdorsal region with three indistinct keels.

Profile slightly depressed at occiput. Mouth subterminal. Eye little longer than snout, $3\frac{1}{4}$ in head, $1\frac{1}{2}$ in interorbital.

Median series of scales on nuchal region ciliate. Lateral scales entire. Ventral scales finely serrate. Basal half of the caudal lobes scaled.

Highest dorsal ray about equal to the head. Anal short truncate, the anterior rays reaching the caudal; ventrals not to vent; pectorals not to ventrals.

Light brown with metallic reflections; light lines along the series of scales; dorsal in one specimen with many dark points.

Head $3\frac{3}{5}$; depth $2\frac{1}{3}$–$2\frac{2}{3}$. D. 12–13; A. 9–10. Scales 5–32 to 34–5.

16. CURIMATUS MAGDALENÆ.

Sardina blanca.

Curimatus magdalenæ Steind., '78a, 34 (Rio Magdalena); id. '79a (Mamoni River, Panama); id. '80a, 15 (Cauca).

Habitat, Rio Magdalena and tributaries; Panama.

17. CURIMATUS GILBERTI.

Papa-terra.

Curimatus gilberti Quoy and Gaimard, 219, pl. 48, fig. 1 (Rio Macacu).
Curimatus gilberti C. and V. xxii., 1849, 16 (Rio Janeiro; Rio Macacu); Gthr., '64a, 289 (copied); Steind., '74a, 29 (Rio Parahyba near Campos, Mendez, and Juiz de Fora; Rio Macuri above Porto Alegre; Rio Muriahe; Rio Itabapuana).
Curimatus voga Hensel, '70a, 78 (S. Leopoldo, Rio dos Sinos).
Curimatus albula Lütken, '74a, 127 (Rio das Velhas and tributaries); id. '75a, 186 and ix.

Habitat, rivers of southeastern Brazil from Rio Plata to Rio San Francisco.

Many specimens from Buenos Ayres; Rio Grande do Sul; Santa Cruz; Minas Geraes; Campos; Mendez; Muriahe; Sao Matheos; Itabapuana; Porto Alegre.

Rather deep and stout, the dorsal and ventral outlines usually equally arched. Preventral region somewhat flattened, or more usually rounded: no enlarged median series of scales. Postventral region rounded, with an obtuse median keel. Back in front of dorsal broad and rounded, a few scales in front of the dorsal being keeled. Postdorsal region somewhat flattened or rounded.

Anterior profile straight or somewhat depressed, upper profile arched. Eye little longer than snout, $3\frac{1}{2}$–4 in head, $1\frac{2}{3}$–2 in interorbital.

Scales persistent, crenate; caudal naked.

Fins all low. Highest dorsal ray shorter than the caudal lobe, which is usually shorter than the head. Anal slightly emarginate, not reaching caudal. Pectorals not near reaching to ventrals, ventrals not to vent.

Silvery, darker above. Tips of dorsal and middle caudal rays occasionally dusky. Sometimes a dark line or band along the tail, terminating in an elongate black spot at the caudal.

Head $3\frac{1}{2}$–$3\frac{5}{6}$; depth $2\frac{2}{3}$–3. D. 11–12; A. 10–11. Scales 6–36 to 41–5 to 6.

17b. CURIMATUS GILBERTI BREVIPINNIS var. nov.

Type, No. 789. One specimen, .14 m. Rosario (La Plata); Captain Brooks.

More elongate than *gilberti*. Preventral region flattened, with a median series of enlarged scales. Profile depressed at the occiput. Eye

3½ in head. Silvery, with purple and greenish reflections. Lateral scales with a frosted appearance. Head 4; depth 3⅓. D. 11; A. 9½. Scales 5–39–5.

18. CURIMATUS PLUMBEUS sp. nov.

Types, eight specimens, .053–.13 m. Lake Hyanuary; Thayer Exped.
No. 20,348, 15 specimens, .075–.095 m. Lake Hyanuary; Navez.

Closely related to *C. spilurus* and *C. magdalenæ*.

Elongate slender. Preventral region flat, without distinct lateral keels; postventral region with indistinct median and lateral keels. A few predorsal scales keeled, region before them flattish. Scales partly dentate, partly cycloid. Lateral scales with widely diverging keels. Caudal lobes naked.

Profile slightly convex, not very steep.

Eye 3–3⅜ in the head, 1⅓ in the interorbital, which is less than the depth of the head at the pupil.

Air-bladder extending to the anal.

Origin of dorsal little nearer to tip of snout than to tip of adipose fin. Pectorals not reaching to ventrals; ventrals about to vent, their origin equidistant from tip of snout and base of caudal. Caudal lobes long, pointed, equal, and much longer than the head.

Plumbeous with silvery and bluish reflections; a silvery lateral band; no dark caudal spot.

Head 3¾; depth 3¼–3½. D. 13; A. 10–11. Scales 5–37–5.

Eight specimens from Obidos may also be referred to this species.

19. CURIMATUS NAGELII.

Curimatus nagelii Steind., '81b, 11 (Rio Janeiro).

20. CURIMATUS LEUCOSTICTUS sp. nov.

Types, No. 787, one specimen, .11 m. to base of caudal. Rio Negro; J. C. Fletcher.
No. 20,315, one specimen, .075 m. to base of caudal. Lago Alexo; S. V. R. Thayer.

Elongate, rather slender. Preventral region flat, with a median series of scales and obtuse keels laterally; postventral region with an obtuse median keel. Predorsal region narrow, with a median keel; postdorsal region with obtuse lateral keels.

Profile somewhat depressed at the occiput in the larger specimen. Eye with narrow adipose lids, ¾ in snout, 2⅝ in head, 1⅓ in interorbital.

Scales of the back and breast pectinate, those of the sides more weakly ctenoid. Base of caudal rays scaled.

Highest dorsal ray shorter than the head. Anal emarginate, the tip

of the highest ray scarcely reaching the lower caudal fulcra. Ventrals reaching nearly to the vent, pectorals $\frac{3}{4}$ to ventrals.

Light brown above, a white lateral band, and silvery below. Everywhere with metallic reflections. A golden stripe along the lateral series of scales. A white spot at base of each caudal lobe.

Head $3\frac{5}{6}$; depth little more than 3. D. 12-13; A. 9-10. Scales 7-45 to 47-6.

This species differs from *bimaculatus* in the partially-scaled caudal, the color, etc.

21. CURIMATUS PLATANUS.

Curimatus platanus Gthr., '80a, 12 (Rio de la Plata).

22. CURIMATUS ASPER.

Curimatus asper Gthr., '68a, 243, fig. 8 (Xeberos; Huallaga).

23. CURIMATUS RUTILOIDES.

Huimba-shitari.

Curimatus rutiloides Kner, '59a, 141, pl. I., fig. 2 (Matto Grosso; Barra do Rio Negro); Gthr., '64, 290 (copied); Cope, '71a, 258 (Ambyiacu); Steind., '81a, 35 (Teffé; Manaos; Matto Grosso; Jatuarana); Steind., '82a, 11 (Huallaga).

Habitat, Amazons and tributaries.

24. CURIMATUS HYPOSTOMUS.

Curimatus hypostomus Boulenger, '87a, 172 (Ucayale).

25. CURIMATUS MIVARTII.

Curimatus mivartii Steind., '78a, 32, pl. 13, fig. 1 (Rio Magdalena); id. '80a, 15 (Cauca).

26. CURIMATUS LEUCISCUS.

Curimatus leuciscus Gthr., '68a, 239 (Huallaga).

Habitat, Huallaga; Obidos; Hyavary; Manacapuru.

Four specimens, .10-.15 m. Obidos.

Elongate slender; ventral outline straight from tip of snout to near anal. Dorsal outline arched, especially in front of the dorsal. Preventral region flattish; postventral region rounded. Predorsal region with a median keel; postdorsal region rounded.

Profile not depressed over eyes. Mouth inferior. Eye little longer than snout, 3-$3\frac{1}{3}$ in head, $1\frac{1}{3}$-$1\frac{3}{8}$ in interorbital.

Scales serrate, somewhat deciduous. Caudal naked.

Highest dorsal ray about equal to the head in length. Anal short,

emarginate, the longest ray reaching the caudal. Ventrals extending about to vent, pectorals not to ventrals.

Silvery below, light brown above. A blackish spot in front of the dorsal, another behind the occipital process; a white lateral band.

Head 4–$4\frac{1}{4}$; depth $3\frac{2}{3}$–$3\frac{3}{4}$. D. 12–13; A. 10–11. Scales 11–64 to 67–9.

Ten specimens from Manacapuru and one from Hyavary have the scales 10–60 to 64–8.

27. CURIMATUS VITTATUS.

Roncador.

Curimatus vittatus Kner, '59a, 139, pl. I., fig. 1 (Guapore; Rio Negro); Gthr., '64a, 292 (copied).

Habitat, Amazon, Solimoens and tributaries.

Two specimens, .15–.24 m. Lake Hyanuary; Teffé.

Compressed, the back somewhat elevated, making an angle at the first dorsal ray. The back rounded, without keels. Preventral region flat, with lateral keels; postventral region with a strong median and indistinct lateral keels.

Scales thin, persistent, entire or crenate.

Profile somewhat depressed at the occiput. Mouth inferior. Eye 1 in snout, $3\frac{1}{3}$ in head, $1\frac{3}{8}$–$1\frac{5}{8}$ in interorbital.

Anterior dorsal rays high, about equal to head in length. Caudal broad, the rays many times branched. Anal emarginate, the longest ray not reaching tip of last ray. Pectorals extending to the ventrals in smaller specimens, much shorter in larger; ventrals to vent in smaller specimen.

Larger specimen silvery white, with indistinct cross-bars on the back. Smaller specimen iridescent peacock-blue; back darker, with blackish cross-bands; a dusky band along the lateral line.

Head $3\frac{1}{3}$–$3\frac{2}{3}$; depth $2\frac{4}{5}$–3. D. 12; A. 12. Scales 11–56–6 or 7.

28. CURIMATUS OCELLATUS sp. nov.

Types, three specimens, .18–.24 m. Xingu; Senhor Vinhas.

Elongate, compressed fusiform. Dorsal and ventral outlines regularly curved. Back and belly rounded. Predorsal line scaled.

Head subconical, the mouth terminal. Adipose lids leaving but a narrow vertical slit over the pupil. Eye $1\frac{1}{3}$ in snout, $4\frac{1}{4}$ in the head, 2 in the interorbital.

Scales of about equal size, their margins entire.

Air-bladder scarcely reaching the anal.

Origin of dorsal little nearer to tip of snout than to base of caudal.

Caudal widely forked, the outer lobes longer than the head, the middle rays less than an orbital diameter in length. Anal emarginate. Pectorals and ventrals of about equal length, equal to snout and orbit.

Plumbeous above, abruptly silvery below the third series of scales above the lateral line. An oval blackish spot near the fortieth scale of the lateral line, its shorter, vertical diameter about equal to half an orbital diameter.

Head, $3\frac{1}{2}$–$3\frac{4}{7}$; depth, $3\frac{4}{7}$–4. D. 12–(13 when last ray is divided); A. 10–11. Scales, 12–67 to 76–11.

29. CURIMATUS ISOGNATHUS sp. nov.

Types No. 20,814, one specimen, .155 m. to base of caudal. Lago Alexo; S. V. R. Thayer.

No. 20,214, one specimen, .185 m. to base of caudal. Içą; W. James.

No. 20,208, one specimen, .18 m. to base of caudal. Manacapuru; W. James.

No. 20,225, one specimen, .12 m. to base of caudal. San Paolo; W. James.

No. 20,224, one specimen, .14 m. to base of caudal. San Paolo; W. James.

Related to *C. rutiloides* and *C. asper*. The preventral region broad, rounded, the jaws equal.

Shape of *rutiloides*, the dorsal and ventral outlines equally arched. Postventral region trenchant. Back broad, rounded.

Profile regularly convex, not depressed at the occiput; mouth terminal. Head broad. Eye comparatively small, 1 in snout, 4 in head, 2 in interorbital.

Scales all ciliate; caudal naked.

Fins all low, highest dorsal ray shorter than the head. Ventrals not reaching to vent, pectorals not to ventrals.

Silvery, bluish above.

Head $3\frac{2}{5}$–$3\frac{3}{5}$; depth $2\frac{1}{3}$–3. D. 12–13; A. 11–12. Scales 12 or 13–51 to 53–8 or 9.

30. CURIMATUS KNERII.

Curimatus cyprinoides Kner, '59a, 143 (Barra do Rio Negro; Surinam), —not of Linnæus.

Curimatus knerii Steind., '76a, 35 (Teffé); id. '81a, 35 (Teffé; Manaos; Rio Branco; Surinam).

Habitat, Surinam, Solimoens, Amazon west of Rio Para.

Many specimens. Montalegre; Porto do Moz; Rio Negro; Tonantins; Lake Hyanuary.

Dorsal and ventral outline about equally arched; form rather deep and compressed. Preventral region flat, with a median series of enlarged scales and lateral keels; postventral region trenchant, with a median series of equitant scales. Back rounded.

Scales rather small on the back, becoming a little larger toward the

breast, all crenate or serrate. Caudal naked. Lateral line decurved anteriorly.

Profile more or less depressed at the occiput, the head wide; mouth more or less inferior. Eye about 1 in snout, 3–3½ in head, 1⅓–1⅔ in interorbital. An anterior and a posterior adipose lid.

Some of the dorsal rays filiform and reaching in some specimens past the adipose. Caudal broad, the upper lobe little longer than the head. Anal long and low, emarginate, its base equal to snout and half the orbit; the tip of the longest ray reaching little if any past the base of last ray. Pectorals reaching to ventrals or shorter, ventrals not to vent.

Silvery, bluish above. Dorsal with black dots.

Head 3⅔–3½; depth 2⅔–2¾. D. 12–13; A. 11–12. Scales 14–60 to 64–8 to 9.

31. CURIMATUS CYPRINOIDES.

Salmo cyprinoides Linnæus, 1766, 514.

Characinus cyprinoides Lacépède, 1801, "272 and 274."

Curimatus cyprinoides C. and V. xxii., 7 (Amazon; Surinam; Essequibo; Cayenne); Castelnau, '59a, 57 (Amazon); Gthr., '64, 290 (River Capin, Para); Cope, '71a, 258 (Ambyiacu).

Salmo edentulus Bloch, pl. 380; Bloch and Schneider, 1801, 472.

Habitat, Amazons and tributaries; Guianas.

Dr. Boulenger has kindly examined the specimens of this species in the British Museum. These have ordinary scales in the postventral region. Dr. Steindachner is certainly wrong in identifying specimens from the Rio Puty with a serrate belly with those in the British Museum.

A large number of specimens from Para represent the *C. cyprinoides* as understood by Dr. Günther.

The pectorals scarcely reach the ventrals. Scales 14 or 15–56 to 60–8 to 9.

Some of the references that we have given with this species may perhaps refer to *C. knerii*.

32. CURIMATUS MACROPS sp. nov.

Types, No. 20,305, 20,302, 20,309, 20,301, over twenty specimens. Rio Puty; O. St. John.

No. 20,311, eight specimens. San Gonçallo; O. St. John.

A species very abundant in the Rio Puty, reaching .25 m. in length.

Compressed ovate, rather deep, the back and belly equally arched. Preventral region flat, with a median series of large scales; postventral region very narrow, the median series of scales equitant. Back narrow, not keeled.

Profile greatly depressed at the occiput, mouth more or less inferior. Eye large, longer than snout, 3 to $3\frac{1}{3}$ in the head, $1\frac{1}{3}$ in interorbital.

Scales of the back small, becoming larger towards the breast, where they are several times as large as on the back. All the scales are more or less ciliated, without longitudinal ridges.

Highest dorsal ray about equal to the length of the head. Caudal broad, widely forked, the lobes shorter than the head. Anal long, emarginate, the tip of the first rays scarcely reaching the base of the last, shorter in young. Base of anal equals head behind the pupil. Pectorals reaching to ventrals, ventrals not to vent.

Dusky above, light below, everywhere with metallic reflections.

Head $3\frac{3}{5}$–$3\frac{1}{3}$, depth $2\frac{3}{5}$–$2\frac{4}{5}$. D. 12–13; A. 13–14. Scales 16–61 to 70–10.

Other specimens from San Paolo may be referred to this species.

33. CURIMATUS FALCATUS sp. nov.

Types, No. 20,340, three specimens, .18–.23 m. Xingu; Senhor Vinhas.

No. 20,189, one specimen, .18 m. Gurupa; Agassiz.

Closely related to *C. knerii*, from which it differs in having a strictly terminal mouth.

Shape of *C. knerii*, the profile less depressed, the postventral ridge less prominent. A very broad anterior and posterior adipose lid. Dorsal emarginate. None of its rays filiform. Anal long and falcate, its base somewhat longer than the snout and half the orbit. Highest anal ray reaching posterior third of the base of the anal. Pectorals not nearly reaching to ventrals, and ventrals not to vent.

Head $3\frac{3}{5}$; depth $2\frac{1}{2}$. D. 11–13; A. 12–13. Scales 14–64–11.

34. CURIMATUS SIMULATUS sp. nov.

Types, No. 20,194, three specimens, .155 to .165 m. Tonantins; L. Agassiz.

No. 20,198, five specimens, .145 to .16 m. Fonteboa; L. Agassiz.

Related to *C. essequibensis*, differing in the vertical scaling.

Back greatly arched, profile steep. Preventral region flat; postventral region with a prominent keel. Predorsal region trenchant.

Scales all more or less ciliate; caudal naked.

Profile somewhat depressed at the occiput. Mouth inferior, the snout pointed. Eye 1 in snout, $3\frac{1}{3}$–$3\frac{1}{2}$ in head, $1\frac{3}{5}$ in interorbital.

Highest dorsal ray longer than head. Caudal widely forked. Anal emarginate, the longest ray reaching past the base of last ray. Ventrals reaching vent, which is just in front of the anal. Pectorals reaching slightly beyond origin of ventrals.

Silvery, bluish above. Dorsal with many minute black dots, some of which are aggregated near the middle of the fin to form an ill-defined band; tips of the dorsal and middle caudal rays blackish.

Head $3\frac{1}{3}$–$3\frac{2}{3}$; depth $2\frac{1}{3}$–$2\frac{5}{8}$. D. 12–13; A. 12–14. Scales 14–51 to 53–6 or 7.

Three of the specimens from Fonteboa differ considerably from the rest. They have the back much less elevated. Eye $1\frac{1}{3}$–$1\frac{2}{3}$ in interorbital. Highest dorsal ray equal to the length of the head. Ventrals not reaching to vent, pectorals scarcely to ventrals. Anterior and upper margin of the dorsal black; a blackish band on the middle of the back from dorsal to caudal.

Depth $2\frac{2}{3}$–$2\frac{3}{4}$.

35. CURIMATUS SCHOMBURGKII.

Curimatus schomburgkii Gthr., '64, 291 (British Guiana; Demerara).

Habitat, Guianas.

One specimen, .19 m. to base of caudal. Surinam; Prof. Wyman.

Preventral region flat, with strong lateral keels; postventral region trenchant, with a median series of equitant scales; dorsal rounded.

Profile depressed above the eye. Premaxillary broad, the mouth inferior. Eye a little longer than the snout, $3\frac{1}{4}$ in head, $1\frac{3}{4}$ in interorbital.

Scales crenate, those of the back little smaller than those on the sides below the lateral line; caudal naked.

Origin of dorsal little nearer to tip of snout than to base of caudal. Base of anal about equal to snout and eye to posterior margin of pupil. Tip of highest anal ray extending little beyond base of last ray. Ventrals not reaching to vent, pectorals not to ventrals.

Yellowish golden, darker above.

Head $3\frac{3}{5}$; depth $2\frac{1}{4}$. D. 12; A. 12. Scales 14–55 to 59–8.

36. CURIMATUS ESSEQUIBENSIS.

Anodus cyprinoides M. and T., '49a, 7 (non auct.).
Curimatus essequibensis Gthr., '64, 291 (Essequibo).

37. CURIMATUS PLANIROSTRIS.

Charax, No. 378; Gronow, Zoophyl., I., 123, 1781.
Charax planirostris Gronow, "'54a, 154."
Curimatus planirostris Gthr., '64, 293 (copied).
Curimatus abramoides Kner, '59a, 142, pl. 2, fig. 3 (Barra do Rio Negro).

Habitat, Amazon and Rio Negro.

Four specimens, .11–.18 m. Rio Negro; Obidos.

Compressed, elevated. Preventral region rounded; postventral region trenchant, without carination. Median line before dorsal naked; postdorsal region trenchant. Scales small, more or less deciduous, thin and strictly cycloid.

Anterior profile concave. Eye somewhat greater than snout, about 3 in head, $1\frac{1}{3}$–$1\frac{1}{4}$ in interorbital. A strong anterior and posterior lid in adult.

Origin of dorsal little nearer to tip of snout than to tip of adipose. Some of the anterior dorsal rays produced. Anal emarginate; pectorals not reaching ventrals.

Air-bladder extending to anal.

Iridescent brassy below, purplish and bluish lustre above; immaculate.

Head $3\frac{1}{2}$–$3\frac{4}{5}$; depth $1\frac{9}{10}$–2. D. 12; A. 11; V. 9–10. Lat. l. 86–"90."

38. CURIMATUS LATICEPS.

Curimatus laticeps Cuv. and Val. xxii., 21, pl. 634 (Lake Maracaibo); Gthr., '64, 293 (copied); Steind., '81a, 37 (Rio Guapore; Cujaba; Villa Bella; Silva, Lake Saraca).

Curimatus altamazonicus Cope, '78a, 684 (Peruvian Amazon).

Habitat, Amazons from Villa Bella to Peru; Rio Guapore; Lake Maracaibo.

Sixty specimens, .09–.25 m. Coary; Fonteboa; Villa Bella; Serpa.

Compressed elongate, shape of *C. latior;* head wider and flatter above, upper profile somewhat steeper and more convex. Postventral region compressed trenchant, but without carination; preventral region rounded. Median line before dorsal naked, at least in adult; postdorsal region rounded. Scales somewhat deciduous, very thin, crenate.

Anterior profile somewhat concave. Eye 4 in head, $2\frac{1}{2}$–$2\frac{3}{4}$ in interorbital.

Origin of dorsal little nearer to tip of snout than to tip of adipose fin. Dorsal truncate, or some of the anterior rays produced, as long as the head. Anal emarginate. Pectorals about reaching to ventrals, ventrals usually not to vent.

Air-bladder reaching to near end of anal.

Silvery on sides and below, bluish above.

Head $3\frac{2}{5}$–$3\frac{1}{2}$; depth $2\frac{2}{3}$–3. D. 12; A. 15–17. Lat. l. 94–110.

Very similar to *latior*, but much less abundant.

39. CURIMATUS LATIOR.

Yulilla.

Anodus latior Spix, '29a, 62, pl. 41 (Equatorial Brazil).

Curimatus latior C. and V. xxii., 19; Castelnau, '55a, 58 (Amazon); Kner, '59a, 145 (Rio Negro; Guapore; Cujaba); Gthr., '64, 293 (copied); Steind., '81a, 36 (Rio Negro; Teffé; Serpa; Jatuarana); id. '82a, 12 (Huallaga).

Habitat, Amazons and tributaries from Serpa to Huallaga; Surinam.

About two hundred and fifty specimens, .10–.23 m. Manacapuru; Hyavary; Hyanuary; Coary; Lago Alexo; Tabatinga; Obidos; Rio Negro; Sao Paolo; Teffé; Serpa.

Compressed elongate. Entire ventral region trenchant, but without carination. Median line before dorsal naked in adult, covered with

scales in young; postdorsal region rounded. Scales small, slightly deciduous, thin, and weakly ctenoid, the entire posterior margin ciliate.

Anterior profile little if at all concave. Eye about equal to the snout, 4½ in the head, about 2⅓ in interorbital.

Origin of dorsal little nearer to tip of snout than to tip of adipose fin; dorsal truncate, or some of the anterior rays somewhat produced. Anal slightly emarginate. Pectorals reaching to ventrals, or somewhat shorter; ventrals not to vent.

Air-bladder extending past the origin of anal.

Silvery on sides and below, iridescent bluish and greenish above.

Head 3⅓–3⅔; depth 2⅔–3. D. 11–12; A. 14–17.[1] Lat. l. 97–111.

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PLATE 1.

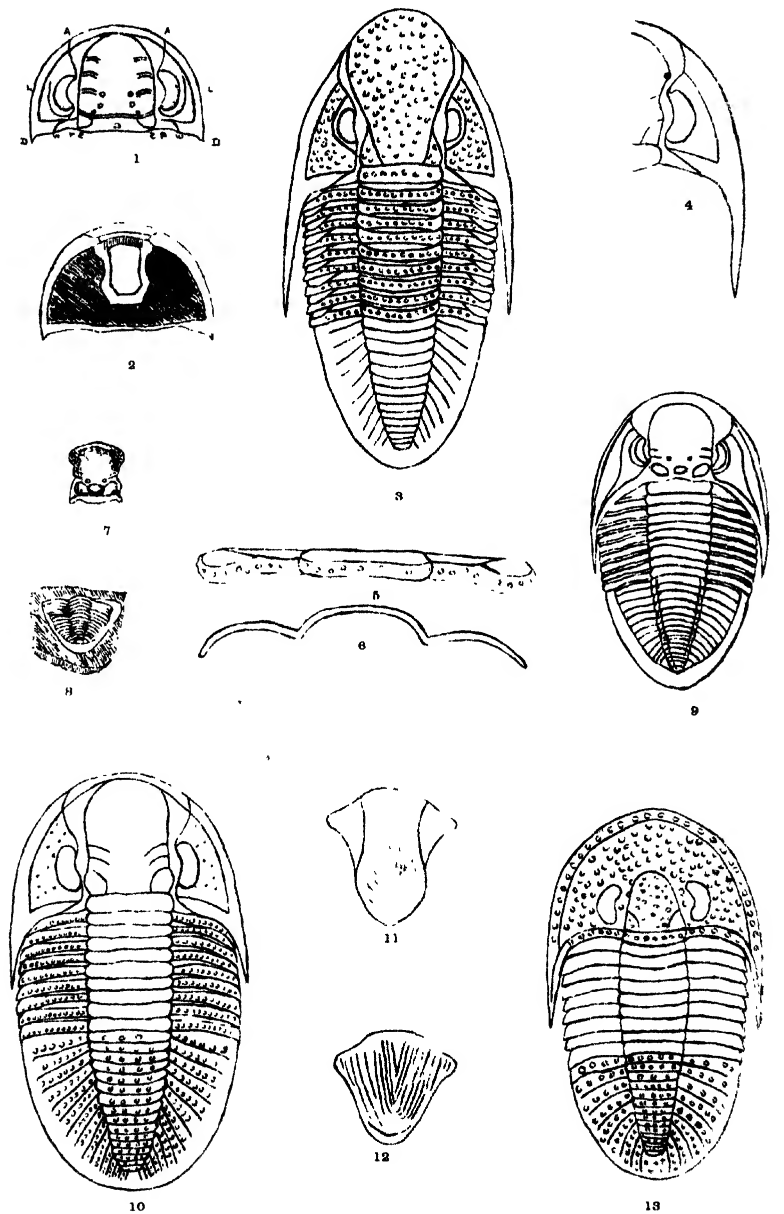
THE IRON-NICKEL METEORITE,

OF MAZAPIL, MEXICO.

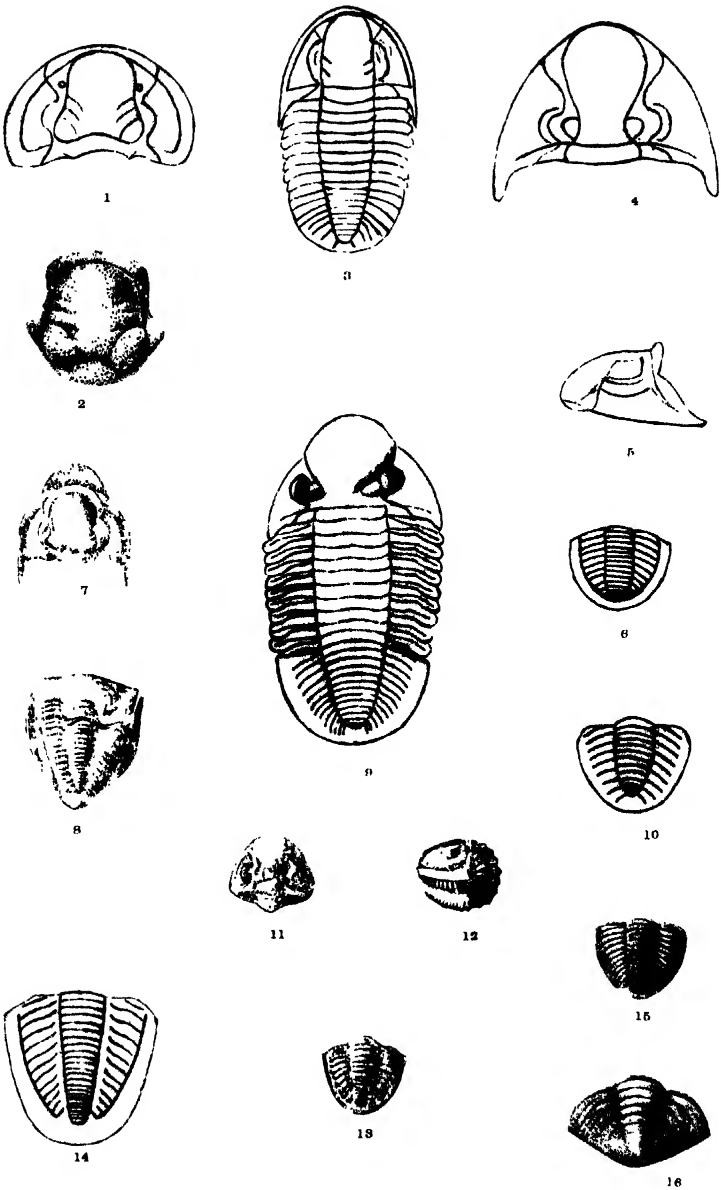
Fell at 9 P. M. on November 27th, 1885, during the shower of Bielid Meteors.

WEIGHS 3864 GRAMMES.

(Three-fourths natural size.)

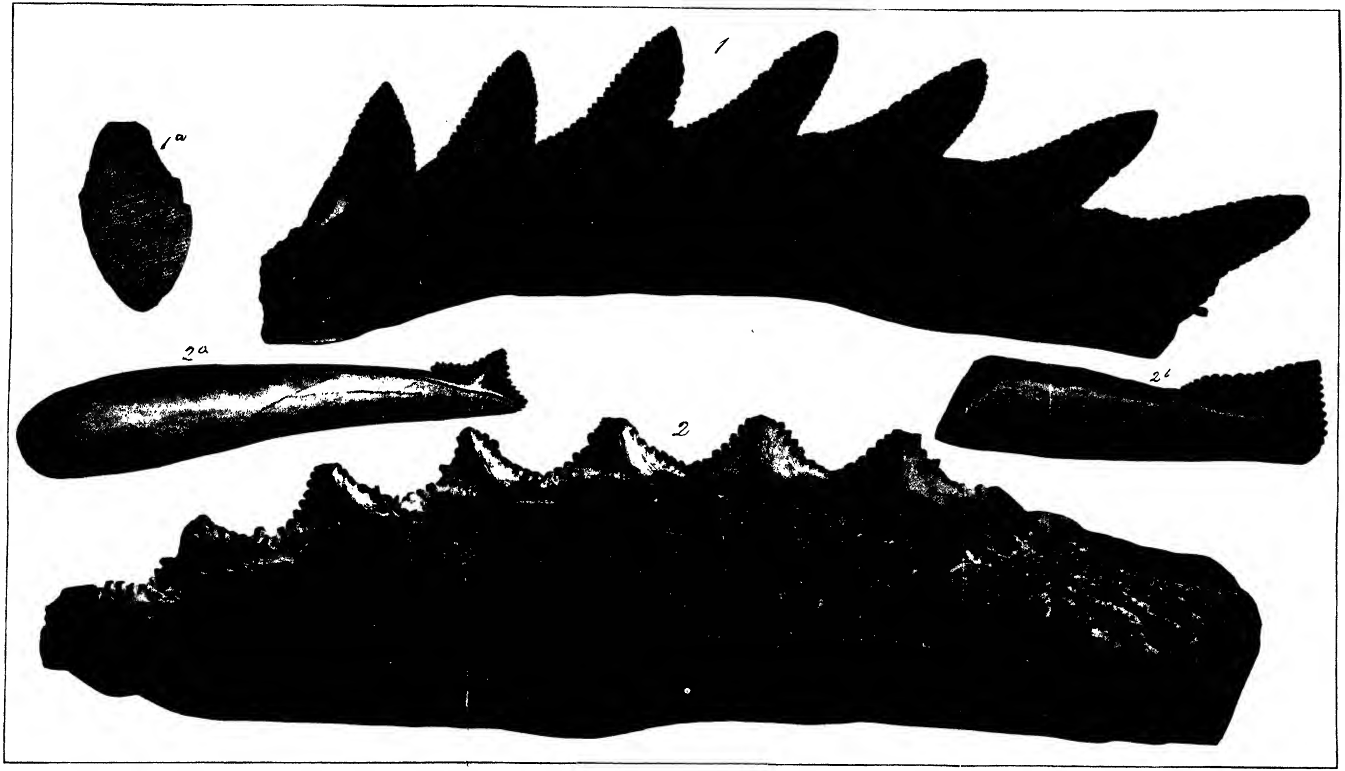


RTOTYPE, E. BIERSTADT, N. Y.



ARTOTYPE. F. BIERSTADT, N. Y.

1. Edestus Davisii Woodw'd. 2. Edestus vorax Leidy.

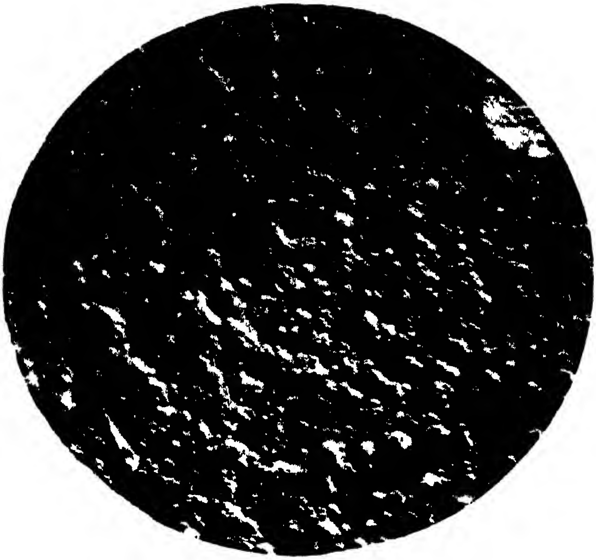


Figs. 1, 1a. Edestus Minor Newb. Figs. 2, 2a, 2b. Edestus. Heinrichsii N & W.

Edestus giganteus Newb.

Archaeophyton Newberryanum, Britton.

Natural Size.

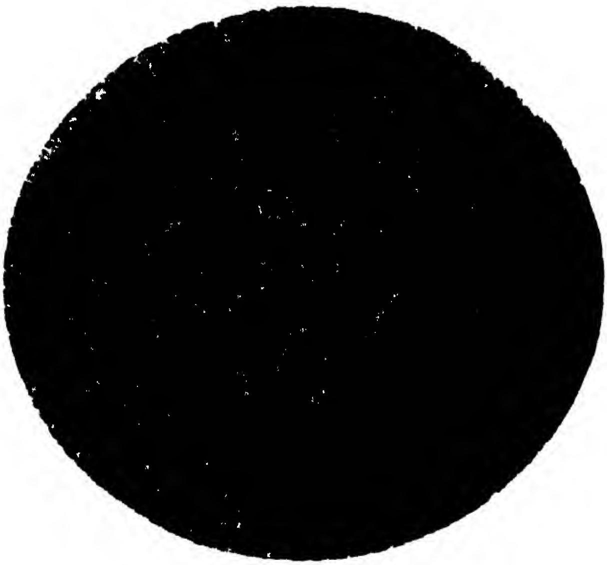


1

2

A. A. J., phot.

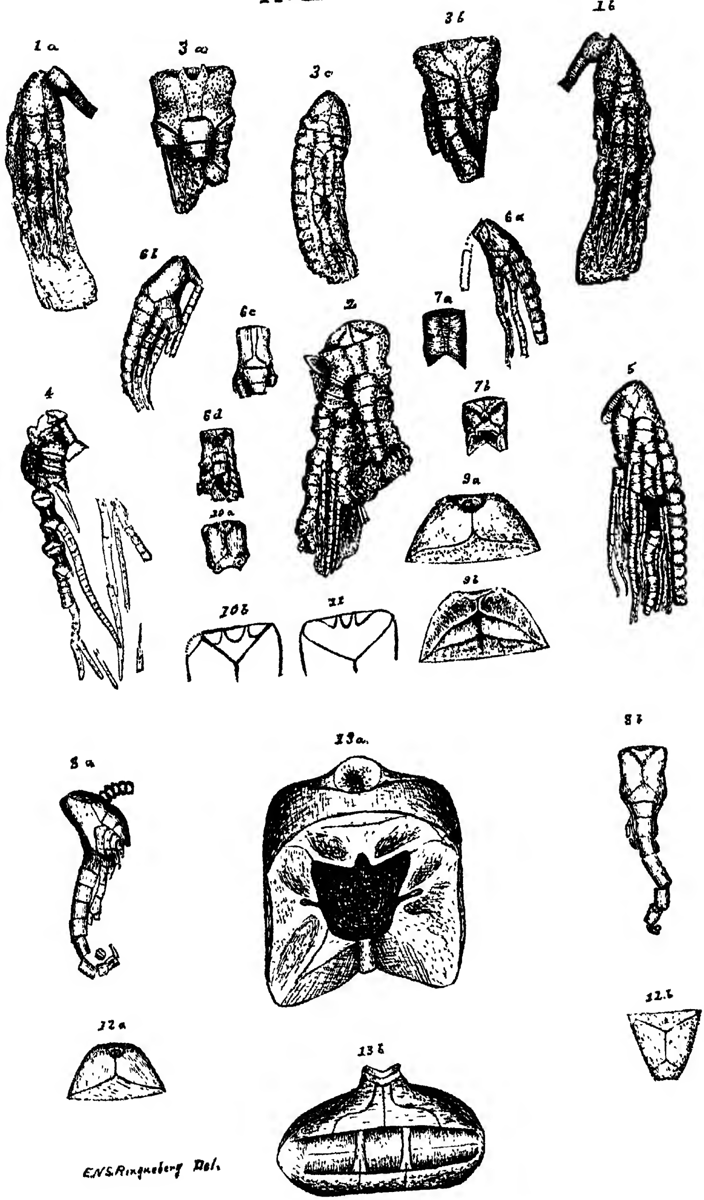
3



4

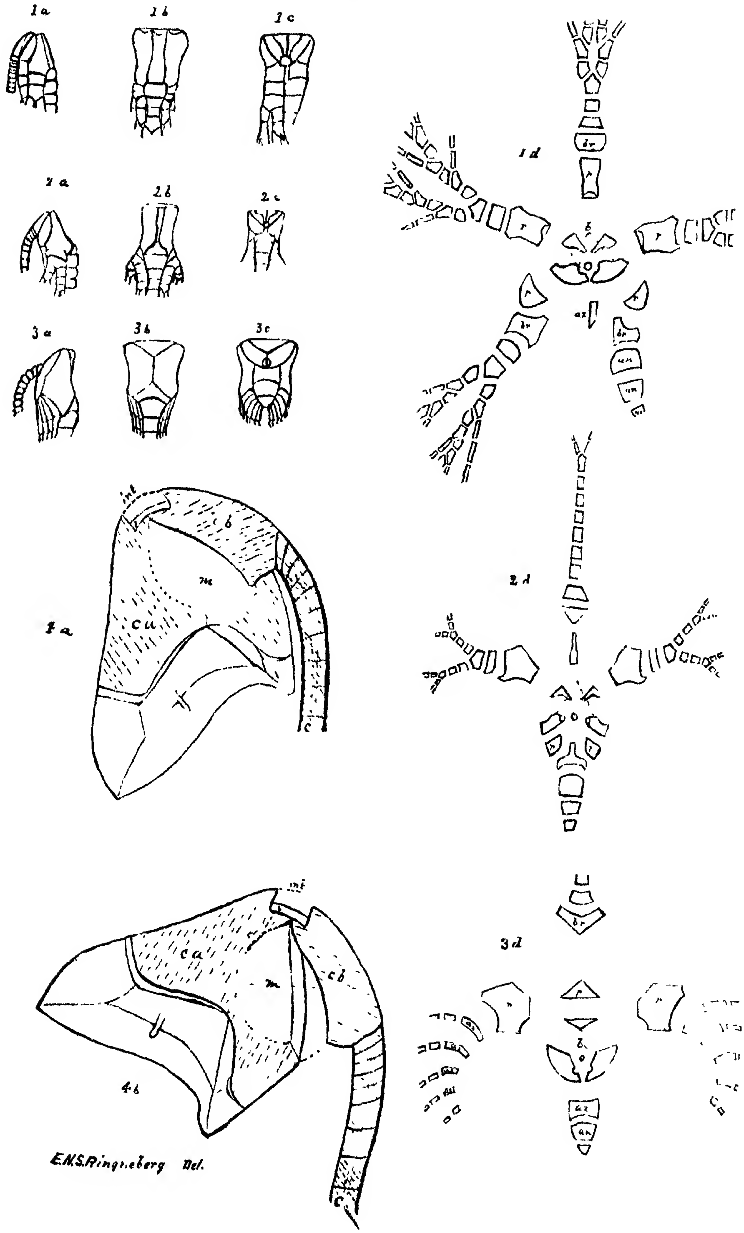
A. A. J., phot.

Pl. X.



E.N.S. Ringueberg Del.

Pl. XI



INDEX.

The names of new genera and species are printed in slightly **heavier type**, described genera and species in Roman, and synonyms in *Italics*. Names of groups, families, and higher divisions are in SMALL CAPITALS.